

The Limestone Begonias of Sabah, Borneo – Flagship Species for Conservation

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Abstract

The 18 *Begonia* (Begoniaceae) species now known from limestone and associated substrates in Sabah, Malaysia, are listed and a key provided for their identification. Twelve are described as new species: *Begonia anthonyi* Kiew, *B. baturongensis* Kiew, *B. berhamanii* Kiew, *B. diwolii* Kiew, *B. heliostrophe* Kiew, *B. keeana* Kiew, *B. lambii* Kiew, *B. layang-layang* Kiew, *B. madaiensis* Kiew, *B. melikopia* Kiew, *B. punbatuensis* Kiew and *B. urunensis* Kiew. All these new species belong to sect. *Petermannia* (Klotzsch.) A.DC., except for *B. diwolii* that belongs to sect. *Diploclinium* (Lindl.) A.DC.. Reasons for placing *B. amphioxus* Sands in sect. *Petermannia* and *B. gueritziana* Gibbs in sect. *Platycentrum* (Klotzsch.) A.DC. are given. *Begonia* is the most speciose genus on limestone in Sabah. Of the 18 species, only one, *B. gueritziana*, is widespread and also found on non-limestone substrates. Of the others, 12 species are known from single limestone hills and 5 are from hills within the same area. Habitat disturbance, which increases the risk of fire, therefore poses the greatest threat to the conservation of these species.

Introduction

As flagship species for the conservation of the limestone flora of Sabah, begonias meet all the criteria. Most are readily recognised as relatives of the begonia house plants, the majority of the limestone species are attractive (Kiew, 2000) and therefore have not only aesthetic appeal but also have commercial potential in horticulture as ornamental plants, as well as exemplifying the need to conserve the limestone flora to ensure its continued existence.

Begonias are instantly recognised by their leaves, which are usually very asymmetric. Although the Sabah species have relatively small flowers, they make up for this deficiency either in their decorative habit or the great variety of leaves. Some are small rosette plants, like *B. gueritziana* and *B. lambii*; others are tall cane-like plants, like *B. keithii* Kiew with bright red, glossy stems; some have leaves coloured magenta underneath, like *B. keeana*; or have pink spots, like *B. malachosticta* Sands, or purple-magenta hairs, like *B. lambii*; others have unusually shaped leaves, such as the swallow begonia, *B. layang-layang*, with leaves curved like a swallow's wing, or *B. amphioxus* with bizarre, narrow peltate leaves pointed at both ends.

These attractive or unusual-looking species hold potential as ornamental plants and several have been successfully grown locally in the Agricultural Park at Tenom under Anthony Lamb's supervision.

That the limestone flora in Sabah is under threat is not in doubt. The major threat is from accidental fires that occur in the periodic drought periods, which are particularly severe in El Niño years. Of the 59 limestone hills in Sabah, only 22 fall within protected forest or a Virgin Jungle Reserve (Lim & Kiew, 1997). The other hills are either no longer surrounded by forest or else lie within commercial forest that has been, is or will be logged. The vegetation on these hills is particularly vulnerable to fire. Beaman *et al.*, (1985) showed that in the Great Burn of 1982/83, the frequency of burning was five times greater in logged-over forest than undisturbed forest. Indeed, the limestone vegetation that burned then, for example, on Bukit Dulong Lambu (Gomantong Cave), Bukit Batangan and Gunung Madai, has not yet recovered.

Other hills are under threat from quarrying as a source of cement, such as Pulau Balambangan and Bukit Tengar (Segarong Cave), or for marble, as at the Borneo Marble Quarry on the Segama River, or for road metal, for example, Batu Pang, Supu and Temambong. Yet others suffer disturbance from birdnest collecting activities, such as Gunung Madai and Bukit Dulong Lambu, where the latter has a village built on the summit. A few have become tourist attractions and are suffering degradation, such as Batu Tulug (Batu Putih) and Batu Punggul. Even protected status does not necessarily ensure protection as is demonstrated by the Virgin Jungle Reserve surrounding Bukit Baturong that has been logged twice (illegally) in the last ten years.

Conservation of the limestone flora therefore requires a strategy to protect its biodiversity and *Begonia* serves as a useful indicator as it is one of the most biodiverse groups of the limestone flora in Sabah being one of the ten most speciose families and the most speciose genus (Kiew, 1998a). In addition, it exhibits extremely high endemism. All its 18 species are endemic to Sabah. Only one species, *B. gueritziana*, is widespread; the rest are narrow endemics. Twelve species are found on single hills and five species on adjacent hills (Table 1). In addition, their distribution reflects the general regional differences of the limestone flora as a whole in Sabah because their distribution is mirrored by the distribution of other species (Kiew, 1998a). Therefore, by using the distribution of begonia species, a pattern emerges of those hills that are of greatest importance in order to protect the maximum biodiversity of the limestone flora. (The only limestone localities without begonia species are the northern islands of Balambangan and Banggi). *Begonia* is therefore an obvious choice as a conservation icon to illustrate the need for conserving a network of hills in

order to include maximum biodiversity

Table 1. Distribution of *Begonia* species on limestone in Sabah.

District	Locality	<i>Begonia</i> Species
(a) <i>species found on single hills</i>		
Pensiangan	Batu Punggul/Batu Tinahas	<i>amphioxus</i> , <i>anthonyi</i>
Pensiangan	Sapulut	<i>layang-layang</i>
Pensiangan	Batu Urun	<i>urunensis</i>
Pensiangan	Pun Batu	<i>punbatuensis</i>
Kinabatangan	Bukit Dulung Lambu	<i>gomantongensis</i> , <i>malachosticta</i>
Kinabatangan	Melikop	<i>melikopia</i>
Lahad Datu	Gunung Madai	<i>madaiensis</i>
Lahad Datu	Bukit Baturong	<i>baturongensis</i> , <i>berhamanii</i>
Semporna	Batu Tengar	<i>keithii</i>
(b) <i>species found on several hills in the same area</i>		
Pensiangan	Batu Punggul/Tinahas, Sapulut	<i>lambii</i>
Kinabatangan	Kinabatangan Valley (3 hills)	<i>postarii</i>
Kinabatangan	Kinabatangan Valley (2 hills)	<i>heliostrophe</i>
Lahad Datu	Segama River (5 hills)	<i>diwolii</i> , <i>keeana</i>
(c) <i>widespread on limestone in Sabah</i>		<i>gueritziana</i>

Two hills are outstanding for their variety of begonia species. Both Bukit Dulung Lambu and Batu Punggul are each home to four begonia species (Kiew, 1998b) as, besides those listed in Table 1, *B. gueritziana* also grows there.

While 17 species are narrow endemics, the eighteenth species, *B. gueritziana*, is not only widespread but is also the only species that is not confined to limestone. It grows on a variety of rock types usually by streams ranging from 30–750 m altitude, the latter on Gunung Kinabalu. However, although widespread, it has not been recorded from limestone in Sarawak. The distribution of begonias on limestone in Sarawak shows the same pattern of high endemism as in Sabah with species being restricted to

particular areas that also reflects the biodiversity patterns of other limestone species (Kiew, 1991), namely species are confined to the Bau area, the Subis area (Niah Cave) or to limestone in the Gunung Mulu National Park. The fact that only eight begonia species have been described from limestone in Sarawak, as opposed to 18 for Sabah, may be an indication of the lack of systematic botanical study than actual lower biodiversity.

Of the 18 species now known from limestone in Sabah, 12 are new species described below. Apart from *B. diwolii* in sect. *Diploclinium* and the widespread *B. gueritziana* in sect. *Platycentrum*, the other 16 species all fall within sect. *Petermannia*. Section *Petermannia* is said by Doorenbos *et al.* (1998) to have male flowers typically with two tepals. However, as more species from Borneo are described, it is likely that this character will prove not to be diagnostic for the section as the majority of the cane-like begonias on limestone in fact have male flowers with four tepals.

Section *Petermannia* is well represented in Borneo and includes several groups of similar species. One is the group of relatively short begonias recognised by Sands (1990) that have bristly stems, leaves that are narrow, obovate and with the midrib in line with the short petiole, the stipules persistent and becoming papery, and the flowers crowded into short inflorescences. From Sabah limestone, two species, *B. anthonyi* and *B. berhamanii*, belong to this group. These species do not grow directly on limestone but are common on the soil around the base of cliffs or on the steep slopes leading up to the hill, where they frequently form drifts.

Another group includes the cane-like begonias that grow directly on the limestone. All these species are extremely decorative, particularly those with an unusual leaf shape (narrow and acutely pointed at both ends), with daintily scalloped leaf margins often coloured bright red, or with attractive variegation. In addition, *B. keithii* has striking red, glossy stems and the many small carmine heart-shaped male flower buds (Kiew, 1998c). Some can withstand full sun and live on the exposed summits, such as *B. baturongensis*, *B. keithii*, and *B. madaiensis*. These species do not flower in deep shade. Of the other species that grow in light shade beneath the tree canopy, *B. amphioxus* and *B. layang-layang* have narrow leaves with a pointed base, *B. keeana*, *B. heliostrophe* and *B. malachosticta*, have, in contrast, broader leaves with a large rounded basal lobe. These cane-like species have great potential as ornamental plants (Kee, 2000). Indeed, Sands (1990) reported that *B. amphioxus* grows well in hanging baskets.

However, the affinity of some species in sect. *Petermannia*, such as *B. lambii*, *B. gomantongensis* Kiew, *B. melikopia*, *B. postarii* Kiew, *B. punbatuensis* and *B. urunensis*, is obscure. There is still a great deal to be learnt about the begonia flora of Borneo where the undescribed species outnumber those already named.

Key to Limestone Begonias in Sabah

- 1a. Small rhizomatous begonias with prostrate stems 2
- 1b. Begonias with erect stems 3

- 2a. Internodes up to 7.5 cm long, leaves well spaced; lamina margin hairy, fruit with 3 equal wings 5. *B. diwolii*
- 2b. Internodes very short, leaves tufted; lamina margin glabrous, fruit with one wing longer than the other two 7. *B. gueritizana*

- 3a. Stem short up to 13 cm tall with few (up to 4) leaves, lamina deeply corrugated 11. *B. lambii*
- 3b. Stem more than 25 cm tall with many leaves, lamina plane 4

- 4a. Mature stem conspicuously bristly, leaf with pinnate venation, basal lobe scarcely developed; male inflorescence compact, up to 2 cm long 5
- 4b. Mature stem glabrous; leaf with palmate-pinnate venation, basal lobe well developed; male inflorescence a lax cymose panicle 7

- 5a. Lamina lanceolate, up to 3 cm wide, basal lobe cuneate or slightly rounded, fruit up to 12 mm wide 4. *B. berhamanii*
- 5b. Leaf obovate, 3 cm or more wide, basal lobe cordate or auriculate, fruit more than 14 mm wide 6

- 6a. Leaf more than 2.5 times longer than wide, basal lobe cordate up to 4 mm long, fruit wing tip pointed 2. *B. anthonyi*
- 6b. Leaf up to 2.5 times longer than wide, basal lobe auriculate up to 10 mm long, fruit wing tip rounded 18. *B. urunensis*

- 7a. Lamina very hairy above 16. *B. postarii*
- 7b. Lamina glabrous above 8

- 8a. Lamina at least 4 times longer than wide, base narrowed to a point, sometimes peltate 9
- 8b. Lamina less than 4 times longer than wide, base broad and rounded, never peltate 11

- 9a. Lamina red-spotted; fruit stalk less than 2.5 mm long, fruit oblong up to 13 x 7 mm 1. *B. amphioxus*
- 9b. Lamina plain green or grey mottled; fruit stalk more than 12 mm long, fruit ovoid or deltoid, 18 x 15 mm or larger 10

- 10a. Stem and petiole crimson; petiole up to 1.5 cm long; lamina not peltate; fruit ovoid and narrower, up to 25 mm wide .. 10. *B. keithii*
- 10b. Stem and petiole pale green; petiole more than 2.5 cm long; lamina peltate; fruit deltoid and wider, more than 29 mm wide 12. *B. layang-layang*
- 11a. Lamina less than 6 cm wide 12
- 11b. Lamina 6 cm or wider 14
- 12a. Lamina more than 3 times longer than wide, pink spotted; tips of fruit wings pointed 14. *B. malachosticta*
- 12b. Lamina less than 3 times longer than wide, not spotted; tips of fruit wings rounded 13
- 13a. Petiole 3—4 cm long; fruit deltoid, shorter than wide, 22—28 mm wide 3. *B. baturongensis*
- 13b. Petiole 1—3 cm long; fruit rhomboid (narrowed distally), longer than wide, 13—20 mm wide 13. *B. madaiensis*
- 14a. Lamina more than twice as long as wide, apex pointing upwards 8. *B. heliostrophe*
- 14b. Lamina less than twice as long as wide, apex pointing downward... 15
- 15a. Lamina obliquely rotund; fruit oblong with pimply surface 6. *B. gomantongensis*
- 15b. Lamina obliquely ovate; fruit deltoid with smooth surface 16
- 16a. Lamina less than 10 cm long; young stems minutely hispid; male flowers with outer 2 tepals 14—15 mm long 17. *B. punbatuensis*
- 16b. Lamina more than 10 cm long; young stems glabrous; male flowers with outer tepals 7—8 mm long 17
- 17a. Lamina up to 16 x 8.5 cm; petioles up to 7 cm long; female flowers solitary, male flowers with 4 tepals; fruit to 2.5 cm long 9. *B. keeana*
- 17b. Lamina 15 x 12 cm or larger; petiole more than 8 cm long; female flowers in pairs; male flowers with 2 tepals; fruit 4—5.5 cm long 5. *B. melikopia*

1. *Begonia amphioxus* Sands

Section *Petermannia*

Sands, Kew Magazine. 7 (1990) 81 & Plate 149; Kiew. Gardenwise. 15 (2000) 13.

TYPE: Batu Punggul *Sands 4045* (not seen).

Distribution: Borneo – SABAH: Pensiangan District, Batu Punggul and Batu Tinahas.

Habitat: Not common, base of limestone cliffs and in light shade on flat tops of subpeaks below the canopy.

Notes: *Begonia amphioxus* is a striking begonia with reddish stems, peltate leaves narrowing sharply to a point at both ends, beautifully marked with deep crimson spots. It shows some variation in leaf shape (peltate or not), number of tepals in the female flower (3 to 5) and in the number of wings in the fruit (2 or 3). It is also unusual in having joined tepals in the female flower.

Sands (1990) referred this species to sect. *Platycentrum* on account of the specimens he collected having female flowers with 2 locules and styles and 3—5 tepals, the male having 4 tepals, and the fruit being 2-winged although he noted that ‘a third wing may occasionally develop in some fruits ... it tends to be smaller.’

Collecting on Batu Punggul allowed the population at the type site to be reexamined as well as that on nearby Batu Tinahas. The majority of fruits on plants at the type site did indeed have fruits with two equal wings and two locules, but on the same plant, a few fruits with three wings (the third wing being smaller) could be found. On Batu Tinahas, plants mostly had fruits with three locules and three equal wings and only a few (on the same plant) had two locules and two wings. In all other respects the two populations were the same. The weak development of the third wing indicates a reduction from the typical state with three equal wings rather than the character state of sect. *Platycentrum* where the third wing is well developed and much larger.

It is certainly an aberrant species for sect. *Platycentrum*, which, as Doorenbos *et al.* (1998) point out, is a section that includes plants that always have fruits with three wings, one of which is markedly larger than the other two. They drew attention to this anomalous situation by listing *B. amphioxus* under the heading ‘Species not attributable to any existing section’. As they noted, apart from the single character of the fruit being two locular, *B. amphioxus* is typical of sect. *Petermannia* in its erect habit, dichasial male inflorescences, solitary female flowers (which may have 4, 3

or 2 tepals but usually has 5) and the style, which is caducous in the fruit. On morphological grounds, there is therefore no doubt that *B. amphioxus* is a member of sect. *Petermannia*. In addition, recently Tebbitt (1999) using molecular data showed that it is affiliated with other species in sect. *Petermannia* and Tebbitt and Maciver (1999) demonstrated the presence of perforate base plates in its endothelial cells, again confirmation that it belongs to sect. *Petermannia*.

Begonia amphioxus is easy to grow. In the Agricultural Park at Tenom, Sabah, it seeds freely and spreads on a lightly shaded limestone rockery. At Kew, it has been propagated from nodal cuttings, grows on all types of soil mix but best on a fibrous mix and it flourishes in hanging baskets (Sands, 1990). It certainly deserves to be more widely known in cultivation.

Specimens examined: SABAH: Pensiangan District - Batu Punggul Ruth Kiew & S. Anthonysamy RK4379 (KEP, L, SAN, SING), Batu Tinahas Ruth Kiew & S. Anthony RK4337 (SAN, SAR, SING).

2. *Begonia anthonyi* Kiew, *sp. nov.*

Section *Petermannia*

A *Begonia cauliflora* Sands foliis basi cordatis et tepalis integris glabris differt — TYPUS: Batu Punggul R. Kiew & S. Anthonysamy RK 4352 (holo SAN; iso K, SAR, SING).

Figure 1

Low, erect, unbranched herb, decumbent and rooting at nodes. *Stem* ferrugineous towards apex, 18–24 cm tall x 3–4(–6) mm diam., internodes 2–5.5 cm long, becoming woody, nodes not swollen. *Stipules* glabrous, narrowly lanceolate, 13–16 x c. 4 mm, margin entire, apex attenuate, persistent. *Leaves* alternate, distant, in life upstanding; *petiole* 2–4(–15) mm long, slightly grooved above; *lamina* very dark plain green, papery when dry, glossy above, obovate, sometimes slightly falcate, (12–)14(–17) x (3–)4.5(–6.2) cm, slightly asymmetric, narrow side curving inwards then rounded at base, broad side rounded (2–)3(–4) cm wide and cordate at base, basal lobes 2–4 mm long, margin dentate and sparsely fringed with bristly hairs, apex attenuate; *midrib* not at an angle to petiole, venation pinnate, lateral veins 6–7 pairs, branching towards margin, sometimes with 1 vein in basal lobe, impressed above and slightly prominent beneath. Plant protogynous. *Male inflorescences* from upper axils, erect, short flattened spike, 5–20 mm long of which peduncle is 5–7 mm, longer than petioles, continuously growing with one or sometimes two flowers open at



Figure 1. *Begonia anthonyi* Kiew

A Habit $\times \frac{1}{3}$, B & C Male inflorescences $\times 1\frac{1}{2}$ and $\times \frac{3}{4}$, D Male bud $\times \frac{3}{4}$, E Open male flower $\times 1$, F Androecium $\times 4$, G Stamen $\times 8$, H Female flower $\times 1$, I Open female flower $\times 1$, J Style and stigma $\times 4$, K T.S. ovary $\times 1\frac{1}{2}$, L Fruit $\times \frac{3}{4}$. (from RK 4438)

a time; *bracts* distichous, pale green, persistent. *Male flower* with pedicel 4—13 mm; *tepals* 2, totally white and scintillating, glabrous, slightly ovate, 9—12 x 6—7 mm, margin entire, apex rounded; *stamens* c. 30, in a sessile, globose cluster c. 4 x 3 mm, *filaments* c. 1.25 mm long, *anthers* pale lemon yellow, ellipsoid, c. 1 mm long, apex emarginate. *Female inflorescences* with 1 or 2 flowers produced from lower leaf axils; *bracts* 2, reddish brown. *Female flower* with *pedicel* 4—6 mm, sparsely hispid; *ovary* pinkish with minute red hairs, narrowly deltoid, 9—16 x 6—16 mm, wings 3, equal, locules 3, placentas axile, bilamellate with many ovules on both surfaces; *tepals* 5, white or rosy red, elliptic, 6—10 mm long, outermost c. 6 mm wide, innermost c. 4 mm wide, margin entire, apex rounded; *styles* 3, c. 5 mm long, joined c. half way then bifurcating; *stigma* papillose forming a continuous twisted band. *Fruit* pendent, pedicel stiff, 3—10 mm long, capsule broadly deltoid, 12—15 x 14—20 mm, locules 3, dehiscing between locules and wings, wings 3, 4—5 mm wide, thinly fibrous, tips pointed; *seeds* brown, minute, broadly ellipsoid, c. 0.25 mm long, base truncate, distally rounded.

Distribution: Borneo: SABAH – Pensiangan District, Batu Punggul, Batu Tinahas.

Habitat: On rocks or on steep earth slopes up to the base of the limestone hill, often gregarious.

Notes: *Begonia anthonyi* belongs to sect. *Petermannia* in being an erect, protogynous begonia with the ovary and fruit with three equal wings. Within sect. *Petermannia*, it conforms to the group of species recognised by Sands (1990) when he described *B. cauliflora* from Sabah that has hispid stems, short petioles, laminas that are widest at or above the middle and narrow to the base (rather than having a well developed basal lobe), has a midrib that is more or less in line with the petiole, and male flowers that are crowded in short axillary inflorescences. *B. berhamanii* described below also belongs to this group. In addition to the characters listed above, species in this group frequently have an unbranched stem, two tepals in the male flower, rather few stamens (to about 30), and the fruit stalk is thick and rigid. This last character contrasts with the other limestone species in this section where the pedicel is long and at fruit maturity is dry and thread-like so that the fruit is dangling.

Begonia anthonyi and *B. berhamanii* grow on soil close to the cliff base or on the steep slope up to the hill. They tend to grow gregariously forming carpets but are local and not found away from the limestone hill.

Begonia anthonyi is distinct from *B. cauliflora* in having a more asymmetric leaf with the broader side more rounded and it is cordate at

the base (not decurrent) and the lamina is green beneath (not crimson to brownish as in *B. cauliflora*), in the male tepals being white and glabrous (as opposed to pink and hirsute outside), and the female tepals glabrous and entire (hairy outside and serrate in *B. cauliflora*). In addition, in *B. anthonyi* flowers open one at a time, whereas *B. cauliflora* is shown as having several flowers open simultaneously on a single inflorescence.

The species is named for S. Anthonymsamy, for many years herbarium assistant at Universiti Pertanian Malaysia, who accompanied me and helped with the preparation of plant specimens on many field trips, including the one to Batu Punggul and Batu Tinahas.

Specimens examined: SABAH: Pensiangan District - Batu Punggul the type and *L. Kuntil* SAN 135786 (SAN), *Sumbing Jimpim* SAN 136091 (SAN); Batu Tinahas R. Kiew & S. Anthonymsamy RK 4438 (SAN, SING).

3. *Begonia baturongensis* Kiew, *sp. nov.*

Section *Petermannia*

A *Begonia keithii* Kiew petiolis longioribus, foliis latioribus basi rotundatibus et fructibus latioribus differt — TYPUS: Batu Baturong R. Kiew *et al.* RK 5026 (holo SAN; iso K, SAR, SING).

Cane-like, glabrous begonia. *Stem* reddish-brown, glossy, erect, 30—50 cm tall and 5—10 mm thick, internodes (5—)9.5 cm long, stems becoming horizontal with many leafy side shoots held horizontally, eventually falling and becoming pendulous, woody, slightly thicker and distinctly annular at nodes. *Stipules* pale green, slightly obovate to lanceolate, 25—28 x 10—11 mm, entire, midrib keeled, apex acute, caducous. *Leaves* alternate, distant, pendant; *petiole* 3—4 cm, slender, slightly grooved above; *lamina* of young plants with light green or grey spots, adult unfolding leaves yellow becoming plain mid-green above and slightly flushed reddish-crimson, sometimes light green beneath, margin red, slightly succulent in live state, thinly leathery when dry, slightly glossy, obliquely ovate, asymmetric, (5.5—)7 x 4.25—5.5 cm, narrow side lanceolate, broad side broadly lanceolate 3.25—4 cm long, base slightly cordate with basal lobe markedly rounded 2.5—4 cm long, margin red, shallowly dentate, apex shortly acuminate; venation palmate-pinnate, *midrib and lateral veins* 4, $\pm$ equal-sized, branched c. midway to margin, c. 3 in basal lobe, prominent beneath.

Plant protogynous. *Male inflorescence* axillary in distal leaf axils, glossy red, erect, cymose panicle to simple cyme in uppermost axil, longer than petioles, 3—4 cm long of which peduncle is 1.25—2 cm, much branched. *Male flower* with *pedicel* 2.5—5 mm long; *tepals* 4, outer surface of outer 2

cerise or deep rosy red, pinkish red inside, glabrous, outer two slightly cordate and concave, 6—7 x 6—8 mm, margin entire, apex acute, inner two pale pink, elliptic, 5—6 x 2.5—3.5 mm, apex acute; *stamens* more than 30, cluster globose, sessile, 2.5—4 x 3—3.5 mm, *filaments* c. 0.5—0.75 mm, *anthers* obovate, c. 0.75 mm long, apex emarginate. *Female flowers* solitary, up to 5 each produced at successive axils, *pedicel* erect, 11—14 mm long, enclosed by 2 large bracts green tinged red, caducous; *ovary* green, obovate, 16—20 x 12—17 mm, wings 3, equal, edges tinged red, locules 3, placentas axile, bilamellate with many ovules on both surfaces; *tepals* (4—)5, rosy red, subrotund, slightly convex, isomorphic, 10 mm long, entire, apex rounded, outer 8—10 mm wide, innermost one c. 6 mm wide; *styles* 3, golden yellow, 4—5 mm long, free almost to base, bifurcating; *stigma* papillose forming a continuous twisted band. *Fruit* dangling on fine thread-like pedicel, 10—30 mm, capsule broadly ovate, (16—)20(—24) x (22—)24(—28) mm, glabrous, locules 3, dehiscing between upper half of the locule and wing, wings 3 isomorphic, thinly leathery, truncate, c. 5 mm wide, thin and fibrous; *seeds* brown, minute, broadly ellipsoid, c. 0.3 mm long, base truncate, rounded distally.

Distribution: Borneo: SABAH – Lahad Datu District, Bukit Baturong.

Habitat: *Begonia baturongensis* grows on limestone rock below the canopy in light shade or on exposed rock ledges and crags.

Notes: This species is typical of sect. *Petermannia* in its cane-like habit and the ovary and fruits having three equal wings. In addition, the female flowers produced in the lower leaf axils with the male inflorescences in the upper ones is a condition found in species of this section.

Like *Begonia madaiensis* (described below), *B. baturongensis* has relatively small leaves, which decrease markedly in size towards the apex, which are well-spaced on long petioles with their apex pointing downwards resulting in the twigs having a dainty zigzag appearance, especially on the lateral horizontal branches. The juvenile leaves of both are variegated, but become plain green with age. The strikingly variegated juvenile leaves are illustrated by Kiew (2000). Male inflorescences are only produced after the female flowers have already become fruits.

In addition, these two species share the same niche growing fully exposed or in light shade on the summit and shoulders of cliff faces and, indeed, they do not flower in shade.

The two species have very different fruits: those of *B. baturongensis* are broader than long and have truncate wing tips, while those of *B. madaiensis* are longer than wide and are narrowed distally. The leaves are

also different, those of *B. baturongensis* have longer petioles (3—4 cm long) and the leaf margin is shallowly dentate, while the leaves of *B. madaiensis* have short petioles (up to 3 cm long) and the margin is scalloped. The flowers of *B. baturongensis* are more decorative being deep rosy red to cerise compared with the white flowers of *B. madaiensis*.

Specimens examined: SABAH: Lahad Datu District - Bukit Baturong: the type and S.P. Lim *et al.* LSP 737 (SAN, SING).

4. *Begonia berhamanii* Kiew, *sp. nov.*

Section *Petermannia*

A Begonia cauliflora Sands foliis angustioribus et tepalis integris glabris differt — TYPUS: Batu Punggul R. Kiew & S. Anthonysamy RK 5046 (holo SAN; iso SING).

Figure 2

Low, erect herb, becoming procumbent and rooting at nodes, indumentum of short hooked hairs, appressed and dense on stem, petiole and lower surface of veins. *Stem* reddish-brown, up to 25 cm tall and 2—3 mm diam., unbranched, woody, internodes 1.5—2 cm long, nodes swollen. *Stipules* lanceolate, 13—14 x 6—7 mm, midrib dorsally strongly keeled with minute scattered hairs, margin entire with a row of fine hairs, apex narrowly attenuate, persistent. *Leaves* alternate, distant, held horizontally; *petiole* 3—5 mm long, shallowly grooved above; *lamina* plain dark green and glabrous above, whitish green (sometimes faintly reddish) beneath, papery when dry, glossy above, slightly asymmetric, narrowly lanceolate and slightly falcate, 12.5—16 x 2.5—3.2 cm of which broad side 1.5—1.8 cm wide, basal lobe cuneate sometimes rounded, 2—3 mm long, margin shallowly dentate, apex attenuate; venation pinnate, *midrib and lateral veins* concolorous with lamina, 7—8 pairs, branching c. midway to margin, 1 vein in basal lobe, slightly impressed above, slightly prominent beneath.

Plant protogynous. *Male inflorescences* from upper leaf axils, sessile, to 2 cm long, shorter than petioles, sometimes bifurcating, flowers congested and covered by distichous, overlapping bracts, only one or two flowers open at a time; *bracts* deep rosy or brown red, lanceolate, c. 12 x 3.5—4 mm, margin dentate with fringe of hairs, persistent. *Male flower* with minutely hairy, pale pink *pedicel* 4—11 mm long, *tepals* 2, opening rosy red, fading to white faintly tinged pink outside, elliptic, 6—8 x 6—7 mm, margin entire, apex rounded; *stamens* 20—30, in hemispherical sessile cluster c. 3 mm across, *filaments* 0.5—1.5 mm long, *anthers* dull white, rotund, c. 0.75 mm long, apex emarginate. *Female flowers* solitary from lower leaf

axils; *pedicel* 2—3 mm long, with densely appressed hairs; *ovary* white, deltoid, 8—12 x 11—16 mm, locules 3, outer surface minutely hairy, wings 3, equal, 4—5 mm wide, glabrous, placentas axile, bilamellate with many ovules on both surfaces; *tepals* 5, rosy red, broadly elliptic, isomorphic, 5—10 mm long, apex rounded, outer 4.5—6 mm wide, inner 3—4.5 mm wide, margin entire; *styles* 3, 4—6 mm long, divided to base, bifurcating; *stigma* papillose forming a continuous twisted band. *Fruit* with stiff, decurved pedicel c. 3—4 mm long, the fruit becoming bent backwards and parallel to stem, capsule broadly deltoid, 11—13 x 10—16 mm, sparsely hispid, 3-locular, dehiscing between locule and wing, wings 3, isomorphic, 2.5—8 mm wide, tips slightly acute, thin almost papery; *seeds* brown, minute, almost globose, c. 0.2 mm long, narrowed to base, rounded distally.

Distribution: Borneo: SABAH – Lahad Datu, Bukit Baturong.

Habitat: Shaded base of limestone cliff on damp soil.

Notes: Like *Begonia anthonyi*, this species belongs to the group of species within sect. *Petermannia* with hispid stems, short petioles, slightly asymmetric laminas with a poorly developed basal lobe and with the midrib almost in line with the petiole. *B. berhamanii* more resembles *B. cauliflora* Sands in its narrowly lanceolate leaves with a slightly rounded basal lobe and in its dense clusters of male flowers. It is readily distinguished from *B. cauliflora* by its narrower leaves with an attenuate apex that are whitish green beneath (in *B. cauliflora* the leaves are 4.2—6.4 cm wide, the apex is acute-acuminate and they are crimson to brownish beneath) and the glabrous, entire tepals of the male and female flowers (those of *B. cauliflora* are hairy outside and those of the female flower are serrate).

The species is named for Berhaman Ahmad who, while he was a research officer at the Forest Research Centre, Forest Department Sabah, ably organised several expeditions to explore and collect the limestone flora.

Specimens examined: SABAH: Lahad Datu District - Bukit Baturong the type and S.P. Lim et al. LSP 715 (SAN, SING).

5. *Begonia diwolii* Kiew, *sp. nov.*

Section *Diploclinium*

A *Begonia speluncae* Ridl. caulibus pilosis, internodiis longioribus et foliis non-peltatis differt — TYPUS: Tempadong, Segama River Ruth Kiew et al. RK 4767 (holo SAN, iso BRUN, K, L, SAR, SING).



Figure 2. *Begonia berhamanii* Kiew

A Habit $\times \frac{1}{2}$, B Stipules $\times 2$, C Male flowers $\times 2$, D Fruit $\times 1\frac{1}{2}$. (from LSP 715)

Figure 3

Creeping, prostrate herb attached to substrate at each node by fibrous roots, old stems setose, indumentum of appressed, concolorous, uniseriate, eglandular hairs c. 1.5 mm long on the young stems, stipules, petiole, leaf margin, lower surface of lamina and particularly dense on veins. *Stem* pale purplish becoming deep reddish brown with age, up to c. 1 m long and 1.5–2 mm diam. near apex and to 4 mm in old stems, succulent, not swollen at nodes, internodes 4–12 mm apart at apex lengthening to 5.5–7.5 cm, stem slightly zigzag with short lateral prostrate branches, c. 10 cm long produced at wide intervals. *Stipules* pale reddish purple, broadly lanceolate, 9–19 x 3.5–8 mm, margin entire, apex distinctly setose, setae 4–5 mm long, persistent. *Leaves* alternate, distant, lamina positioned flat against rock surface; *petiole* brownish or reddish purple, more hispid than stem, 3–7 cm long up to 14.5 cm on pendent branches, 1–3 mm diam., terete; *lamina* rich deep plain green above, deep magenta beneath, thinly fleshy, matt, upper surface glabrous except for a few setose hairs on the veins, orbicular to reniform, smaller leaves slightly asymmetric, large leaves very asymmetric, (2–)4(–6.5) cm long and (2.5–)5(–6.5) cm wide of which the broader side is (1.5–)3(–4.5) cm wide, base slightly cordate but not overlapping, basal lobes shallowly rounded (0.5–)1.5(–3.5) mm long, margin slightly wavy and fringed by long hairs, apex rounded in orbicular leaves, acute in reniform leaves; venation palmate, *midrib* and *lateral veins* concolorous with lamina (occasionally paler), (2–)3, equal sized, bifurcating twice, first near petiole or more than half way towards margin, second close to margin, 1–2 veins in basal lobe, slightly impressed above, slightly prominent beneath.

Inflorescence protandrous, axillary from second node, cymose panicle, pale magenta, sparsely setose, erect, longer than petioles, 7–15 cm long, peduncle 6.5–10.5 cm long, each branch with 1 female flower and several male flowers eventually with up to 3 branches; *bracts* paired at base, brown and papery, narrowly acute with conspicuous midrib, 6–9 x 2.5–3 mm, margin entire, apex setose, caducous. *Male flowers* with pale pink *pedicel* 7–10 mm long; *tepals* 4, outer 2 with the upper tepal deep rosy pink outside, both suffused pink inside, glabrous, broadly oval, 6–9 x 5–7 mm, margin entire, apex rounded to acute, inner 2 almost completely white, oval, narrower, 7–8 x (2.5–)4 mm, apex bluntly rounded; *stamens* c. 30, cluster subglobose with torus c. 1 mm long, *filaments* c. 0.4 mm long, *anthers* lemon yellow, obovate, c. 0.6 x 0.5 mm, apex emarginate. *Female flower* with pale pink to magenta *pedicel* c. 6 mm long; *ovary* pale pink with margin of wings tinged green, sparsely pustulate with occasional short hairs, cordate, c. 3.5 x 3.5 mm, wings 3, equal-sized, c. 1.25 mm wide, base

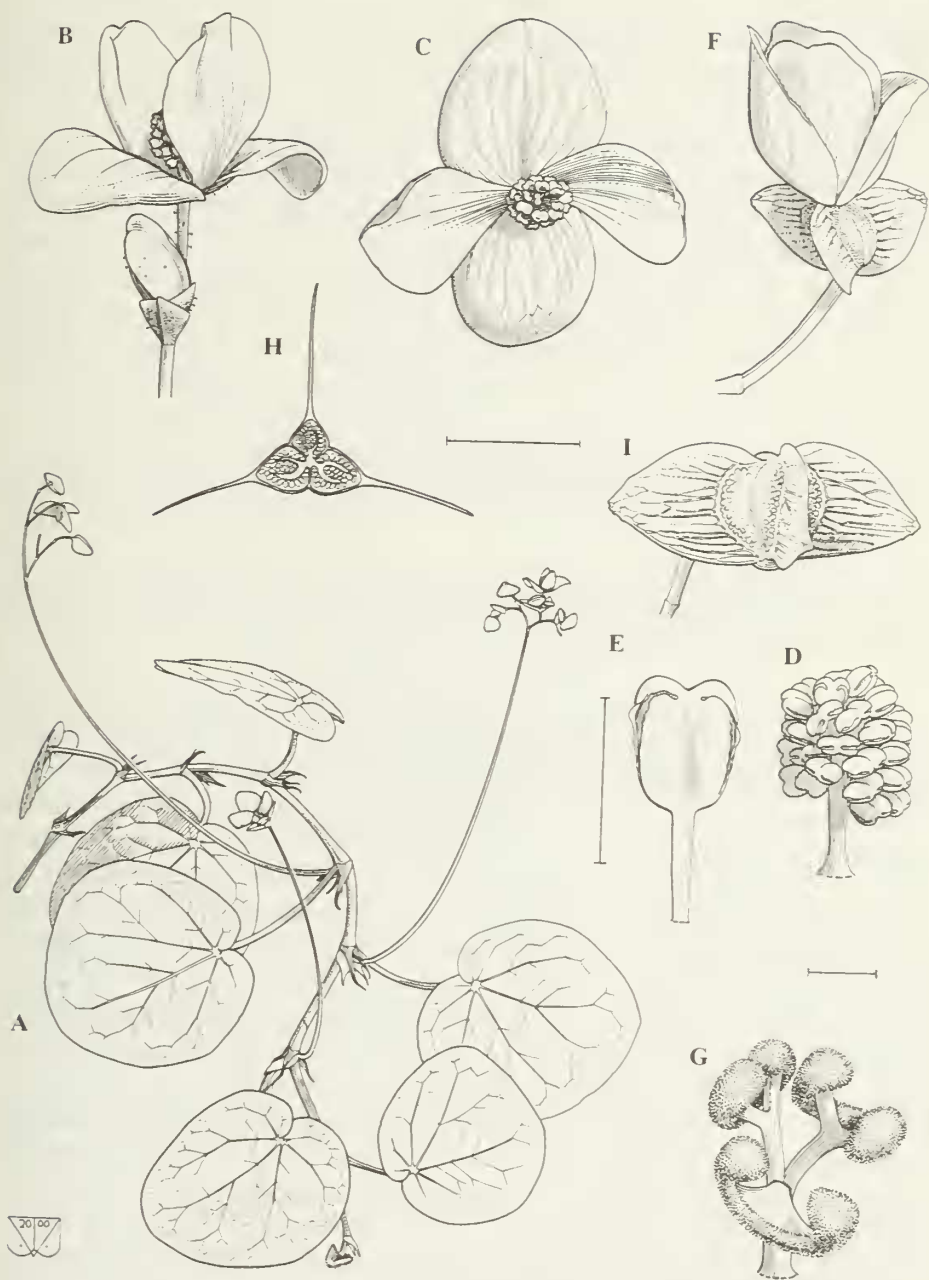


Figure 3. *Begonia diwolii* Kiew

A Habit x $\frac{1}{2}$. B Male flower. C Open male flower. D Androecium. E Stamen. F Female flower. G Style and stigma. H T.S. ovary. I Fruit. (from RK 5073)

rounded, narrowed to apex, locules 3, placentas axile, bilamellate with many ovules on both surfaces; *tepals* 4, c. 4.5—8 x 4—5 mm, margin entire, outer 2 slightly smaller, tinged magenta with outer surface paler inside, scintillating, microscopically pustulate, apex rounded; inner 2 slightly longer, pure white, apex truncate; *styles* 3, c. 3.5 mm long, joined at the base for c. 1.5 mm, then bifurcating; *stigmas* green-yellow, with a lunate, papillose band on each branch. *Fruits* up to 3 per infructescence, pendent, peduncle, branches and pedicels becoming thin, dry and hair-like, 12.5—16.5 cm long, *capsule* 10—13 x 3.5—5 mm, whole fruit becoming dry and papery, glabrous, locules 3, dehiscing between locule and wing, wings 3, equal-sized, broadly rounded, c. 4—5 mm wide; *seeds* brown, minute, broadly ellipsoid, c. 0.25—0.3 mm long, base narrowed, apex rounded.

Distribution: Borneo – SABAH: Lahad Datu District, Segama River (Tempadong, Batu Belas, Borneo Marble Quarry and an unnamed hill by the Lahad Datu road).

Habitat: On vertical and horizontal rock faces from the cliff base in deep shade to light shade near the summit of limestone hills.

Notes: This new species is most distinctive in its habit of producing long prostrate, frequently zigzag stems that creep and root over the rock surfaces (illustrated in Kiew, 2000). The long internodes mean that the leaves are distant and so contrast with other rhizomatous limestone species with leaves with palmate venation, such as *B. gueritziana* in Sabah and *B. speluncae* Ridl. in Sarawak, which both have very short internodes so that their leaves are in a tuft. Furthermore, it cannot be mistaken for *B. gueritziana*, which has much larger and thicker leaves, and fruits with one wing much larger than the other two. In fruit shape (three equal, narrow, rounded wings), leaf shape (small and frequently orbicular) and the inflorescence being longer than the petiole, *B. diwolii* most closely resembles *B. speluncae* but it is readily distinguished from the latter, which not only has short internodes and tufted leaves, but is also glabrous, and the leaves are frequently peltate. In addition, *B. speluncae* is placed in sect. *Reichenheimia* by Doorenbos *et al.* (1998), a section that has placentas with one (not two) lamellae.

This new species belongs to sect. *Diploclinium* Group 1 of Doorenbos *et al.* (1998), which includes the rhizomatous species with palmately veined, often symmetric leaves, bisexual inflorescences that are usually protandrous, male flowers with four tepals and obovate anthers, female flowers with four tepals, and three-loculate fruits with three equal-sized wings and bilamellate placentas.

Many of these characters are shared by sect. *Petermannia*, although species in that section are less usually rhizomatous or palmately veined. However, the one character that does exclude *B. diwolii* from sect. *Petermannia* and places it in sect. *Diploclinium* is its protandry.

The fact that this species is protandrous is not always apparent from herbarium specimens. Observations in the field show that the inflorescences produce three branches in sequence, each of which produces one or two male flowers that open first, followed by a single female flower, then further male flowers, the entire inflorescence therefore eventually producing a maximum of three fruits. Unless a plant is observed in the initial male phase, it appears protogynous with a developing fruit below and young male flowers above.

This charming species with its dainty round leaves magenta beneath and bright pale flowers deserves to be introduced into cultivation. Experimentation in the Singapore Botanic Gardens shows that it grows well on old coral (Kee, 2000).

It gives me great pleasure to name this decorative species for Diwol Sundaling, Senior Herbarium Officer at SAN, who organised the expedition to the Segama River (and many others) and whose enthusiasm and support in the field is much appreciated.

Specimens examined: SABAH: Lahad Datu District – Tempadong the type and Ruth Kiew *et al.* RK5073 Unnamed hill on Lahad Datu road (E. SAN, SING).

6. *Begonia gomantongensis* Kiew

Section *Petermannia*

Kiew, Gardens' Bulletin Singapore 50 (1998) 164.

TYPE: Bukit Dulang Lambu *James Awing* SAN 47257 (holo SAN).

Distribution: Borneo: SABAH – Kinabatangan District, Bukit Dulong Lambu (Gomantong Cave).

Habitat: Base of limestone hill in deep shade on boulders or the foot of cliff faces.

Notes: A member of sect. *Petermannia*, it is distinct from the other limestone species in Sabah in its subrotund leaves, which are held horizontally on long petioles, and its oblong capsules with a pimply surface.

It is known only from Bukit Dulong Lambu.

Specimens examined: SABAH: Kinabatangan District – Bukit Dulong Lambu *James Awing*

SAN 47257 (SAN), S.P. Lim & Ubaldus LSP 785 (SAN, SING), R. Kiew & S.P. Lim BDL 3 (SAN, SING).

7. *Begonia gueritziana* Gibbs

Section *Platycentrum*

Gibbs, Linn. Soc. Bot. 42 (1914) 82 & figure.

TYPE: Kayoh Hills, Tenom L.S. Gibbs 2892 (holo BM).

As more specimens are available, including ones with female flowers, additional information is provided here to supplement the original description:

Rhizome with crowded internodes. *Petiole* 6–13 cm long; *lamina* dark green above, often reddish-purple beneath, 5–8 x 5.5–7 cm, basal lobes scarcely developed 3–18 mm long. *Inflorescences* protandrous, longer than petiole, 11–22 cm long of which peduncle is 10–20 cm. *Male flower* outer two *tepals* broadly elliptic, 11–12 x 7.5–8 mm, inner two narrowly elliptic, c. 11 x 3 mm; *stamens* joined at base, torus c. 1 mm long. *Female flowers* with *ovary* pale green, glabrous, c. 5–9 mm long, locules 2, placentas axile, bilamellate, wing 3 unequal, longer wing c. 4–7 mm wide, two shorter c. 2 mm wide; *tepals* 4, rosy pink, outer two almost rotund, 5–9 x 5–8 mm, margin entire, apex rounded, inner two elliptic, c. 4–8 x 4–5 mm, apex cucullate; *styles* yellow, 2.5–3 mm long, bifurcating; *stigma* a twisted continuous papillose band. *Capsule* c. 10 mm long, longer wing 10–12 mm wide, broadly rounded, slightly concave, two shorter wings 4–5 mm wide, thin, apex slightly acute.

Distribution: Borneo – SABAH: Apart from islands and the coastal areas of the west and north coasts, *B. gueritziana* is widespread in Sabah both on and off limestone having been collected from the Tenom, Keningau, Kota Merudu, Ranau, Labuk Sugut, Kinabatangan and Tawau districts. However, it has not been collected further west than the Kallang Waterfall in Tenom (Ruth Kiew & S.P. Lim RK 4280). It has not been reported from Brunei (Sands, 1996) nor has it been collected from Gunung Api, in the Mulu National Park, Sarawak, the closest limestone to Sabah. It therefore is a Sabah endemic.

It is the only widespread begonia species on limestone in Sabah and is particularly common on all the Kinabatangan limestone hills (even on the smaller, disturbed ones like Supu and Batu Tulug) and has been collected from the Kelabangan Ridge, Batu Urun and Lian Cave. On the other hand, it is absent from limestone in the south (Segama River and

Madai-Baturong limestone) and in the west (Melikop, Pun Batu, Batu Punggul and Sungai Pangi).

Habitat: On limestone, *B. gueritziana* grows in light shade and is most frequent in soil-filled crevices and is particularly common on humus covered ledges (Kiew, 1998b).

Of the begonia species that grow on limestone in Sabah, it is the only species that has been collected from non-limestone substrates (basalt, gabbro and sandstone are cited on herbarium specimens). It has usually been collected from rocks by the edge of streams from near sea level (30 m) up to 750 m altitude on Gunung Kinabalu.

Notes: Gibbs (1914) originally placed *B. gueritziana* in sect. *Reichenheimia* as do Doorenbos *et al.* (1998). However, it is atypical of this section in the ovary having unequal wings, being 2-loculate and each locule having two placentas. These ovary characters clearly place it within sect. *Platycentrum*, with which it is in accordance for all other diagnostic characters, such as the rhizomatous habit, palmate leaf venation, the axillary, protandrous inflorescence (illustrated in Kiew, 2000), male flower with 4 tepals, and the nodding fruit, which dehisces on both sides of the narrower wings.

As in *B. diwolii*, examination of herbarium specimens can be misleading, because if the initial stage with only male flowers is not represented, the inflorescence may appear to be protogynous.

Compared with the begonia flora of Peninsular Malaysia, sect. *Platycentrum* is poorly represented in Sabah, the only other species being *B. adenostegia* Stapf from Gunung Kinabalu.

Although widespread in terms of geography, substrate and altitude, it is rather uniform in habit and leaf shape. However, the population on limestone at Kelabangan is different in having pure white flowers compared to the usual rosy pink ones.

It is apparently an easy species to grow, as at the Agricultural Park, Tenom, it seeds freely and has gone wild on shaded rocks in the Orchid Centre.

Specimens examined: The type and from limestone: SABAH: Kinabatangan District – Kinabatangan Valley, Batu Batangan *Ruth Kiew & S.P. Lim RK 4291* (SAN, SING), *Meijer SAN 23103* (locality misnamed Batu Bilit) (SAN); Batu Temambong Besar *Ruth Kiew & S.P. Lim RK 4192* (SAN, SING), *Lin et al. LSP 1151* (SAN, SING); Keruak FR *Ruth Kiew & S.P. Lim RK 4183* (SAN, SING); Bukit Dulong Lambu (Gomantong) *Meijer SAN 20754* (K), *S.P. Lim et al., SPL 616* (SAN, SING); Supu *J. Singh & Eging SAN 51826* (SAN), Batu Tulug (Batu Putih) *Dewol & Harun SAN 89912* (SAN, SING), *Puasa SAN 10115* (K), *S.P. Lim et al. LSP 625* (SAN, SING), *LSP 771* (SAN, SING); Pensiangan District - Batu Urun *Ruth Kiew & S. Anthony RK4463* (SAN, SING) – also observed on

Baladut and Sarupi (Kinabatangan Valley); Kelabangan (Pensiangan District).

8. *Begonia heliostrophe* Kiew, *sp. nov.*

Section *Petermannia*

A *Begonia malachosticta* Sands foliis majoribus sursum spectantibus differt — TYPUS: Batu Batangan R. Kiew & Lin S.P. RK 4293 (holo SAN; iso BRUN, K, KEP, L, SAR, SING).

Figure 4

Bushy, cane-like, glabrous begonia, usually branched at base from a prostrate rhizome. *Stem* reddish brown or purple, up to 1.25 m x c. 7.5 mm diam., becoming woody, flowering at 60 cm, internodes 5–7 cm long, erect, branching at c. 30 cm, nodes swollen and almost articulate. *Stipules* pale green, lanceolate, 10–15 x 4–6 mm, margin entire, apex setose, caducous. *Leaves* alternate, distant, positioned with the apex held upwards; *petiole* reddish brown or purple, 5–7 cm long, grooved above; *lamina* sometimes with a silvery hue when immature, becoming flecked silver and finally uniformly mid-green at maturity, except for deep crimson patch at junction with petiole, beneath slightly reddish-green between veins, thinly succulent in life, thinly chartaceous dried, glossy above, asymmetric, narrowly ovate (10.5–)14–16(–19) x (3.5–)6–6.5 cm of which broad side is (2.5–)4.5–5 cm wide, basal lobe rounded, (2–)3.5–5 cm long, base cordate but not overlapping, margin reddish, serrulate, apex attenuate; venation palmate-pinnate, *midrib and lateral veins* 3–5 pairs along midrib and 1 pair at base, bifurcating once about halfway to margin and again close to the margin, 2–3(–4) veins in basal lobe, slightly raised above, plane and pale green beneath.

Inflorescences axillary, protogynous, much branched cymose panicle, bright deep magenta, erect, 7.5–10 cm long of which peduncle is 1.75–3.5 cm long, longer than petioles, with 1 or 2 female flowers proximally and many male flowers distally on thin, branches; *bracts* lanceolate, pale green or reddish green, c. 7 x 4 mm, margin entire, apex acute, caducous. *Male flower* with reddish *pedicel* c. 5 mm long; *tepals* 4, white or very pale green, suffused crimson towards base, inner surface glistening, margin entire, apex rounded, outer two concave, almost rotund 4–6 x 4.5–6 mm, inner two broadly elliptic 2–4 x 1.5 mm; *stamens* c. 60, cluster broadly conical, c. 3 mm long including a short torus c. 0.25 mm long, *filaments* c. 0.75 mm long, *anthers* lemon yellow, broadly oblong, c. 0.5 mm long, apex emarginate. *Female flower* pendent in bud then straightening so the open flower is held horizontally; *pedicel* 1.75–2 cm long, crimson, *ovary* glabrous, oblong, c.

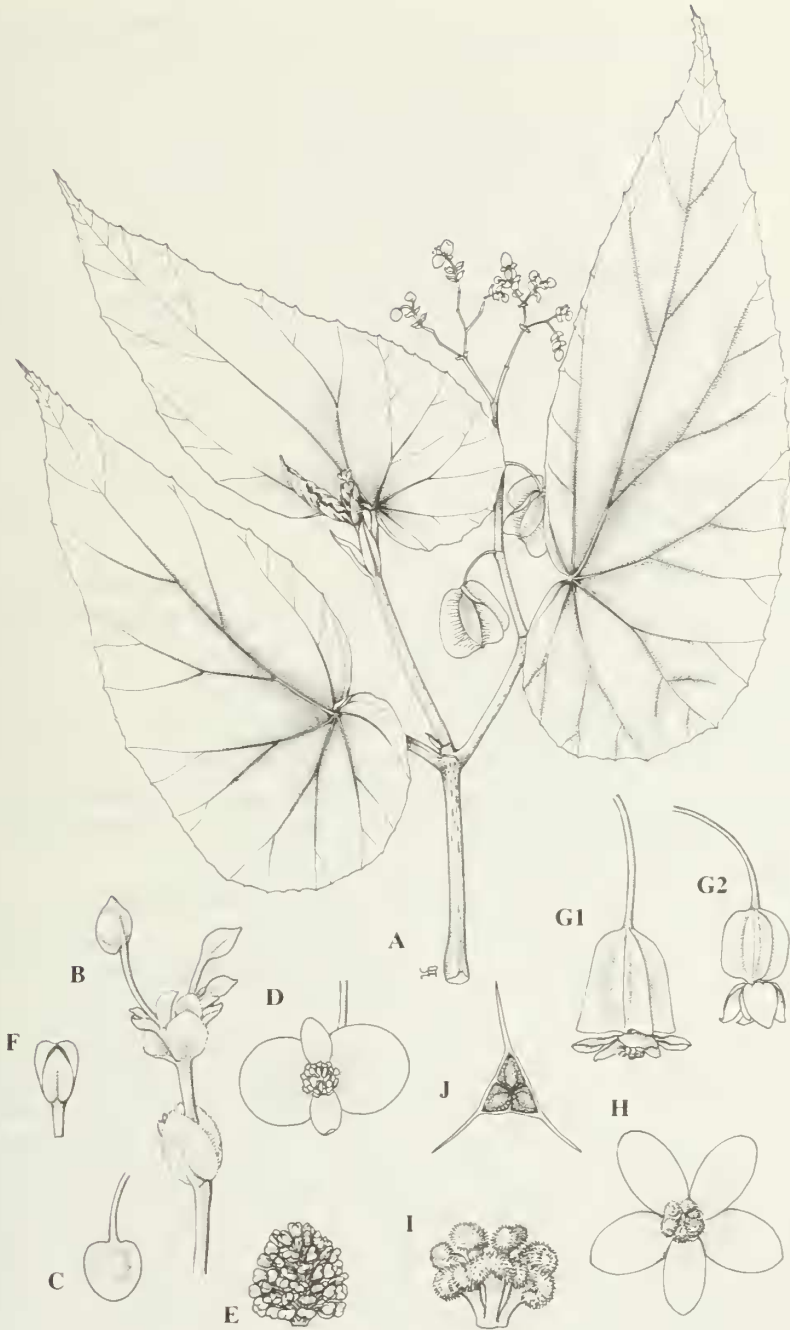


Figure 4. *Begonia heliostrophe* Kiew

A Habit x $\frac{1}{2}$, B Branchlet of male inflorescence x 2, C Male bud x 2, D Open male flower x $2\frac{1}{2}$, E Androecium x 5, F Stamen x 10, G 1&2 Female flower x 1, H Open female flower x $1\frac{1}{2}$, I Style and stigma x 5, J T.S. ovary x 1. (from RK 4293)

15 x 9 mm wide proximally and 14 mm wide distally, wings 3, isomorphic, reddish when immature becoming green with slight reddish tinge on the margins at maturity, locules 3, placentas axile, bilamellate, many ovules on both surfaces; *tepals* 5(—6), pale yellowish green with a peachy tinge, elliptic, isomorphic, c. 10 mm long, outermost 6—9 mm wide, innermost c. 4 mm wide, margin entire, apex rounded; *styles* 3, c. 3 mm long, divided to base, bifurcating, *stigma* bright lemon yellow, papillose forming a continuous twisted band. *Fruit* dangling on a fine hair-like *pedicel*, 2—3 cm long; *capsule* broadly deltoid, 17—23 x 17—22 mm, glabrous, locules 3, dehiscing between locule and wing, wings isomorphic, rounded at base, 7—10 mm wide, tips rounded, thinly fibrous; *seeds* brown, minute, broadly ellipsoid, c. 0.25—0.3 mm long, base truncate, rounded distally.

Distribution: SABAH: Kinabatangan District, Kinabatangan Valley (Batu Batangan and Keruak).

Habitat: On soil at the base of cliffs or in crevices in vertical rock faces from the base to the crest of cliffs in deep or light shade, particularly common on soil-covered ledges in light shade.

Notes: In its cane-like habit, its female flowers with 5 tepals, 3 bifurcating styles that are caducous in the fruit, 3-loculate ovary and fruit with 3 equal wings and bilamellate placentas, it is typical of sect. *Petermannia* but like the majority of limestone begonias, it differs in having 4 tepals in the male flower instead of the typical 2.

It is unique among the limestone begonias in Sabah in that the leaf grows with its apex pointing upwards compared with the usual position where the apex points downward. The species epithet highlights this unusual feature.

It belongs to a group of cane-like begonias that grow in light shade on rock faces that have asymmetric, narrowly elliptic leaves with one basal lobe well-developed and rounded. On limestone, this group includes *Begonia malachosticta*, *B. keeana* and the above species. In addition to the orientation of the leaf, *B. heliostrophe* differs from *B. malachosticta* in its broader, plain (non-variegated leaves), many-flowered male inflorescences and rounded (non-arcuate) wings of the fruit, and from *B. keeana*, besides the orientation and non-variegation of the leaf, by its larger leaves (up to 12.5 x 8.5 cm in *B. keeana*) and yellowish green flowers (compared with the rosy red ones of *B. keeana*).

Specimens examined: SABAH: Kinabatangan District - Batu Batangan the type; Keruak Amin & Matin SAN 108091 (SAN), Ruth Kiew & Lim S.P. RK 4158 (E, K, L, SAN, SAR, SING), RK 4175 (SAN, SING).

9. *Begonia keeana* Kiew, sp. nov.Section *Petermannia*

A Begonia malachosticta Sands foliis latioribus et fructibus latioribus pedicello multo longiore suffultis — TYPUS: Tempadong R. Kiew *et al.* RK 4766 (holo SAN; iso K, SING).

Cane-like begonia, glabrous, root stock woody with several stems. *Stem* reddish brown flecked white, smooth and glossy, to 1.25 m tall and 5–7 mm diam., flowering at c. 30 cm tall, internodes 2–8.5 cm, erect or pendent if growing on edge of cliff face, older stems branching sparingly in the upper 50 cm, branches at 45° to main stem, woody, slightly swollen at nodes. *Stipules* pale green, broadly lanceolate, 14–23 x 7–10 mm, margin entire, apex setose, persistent. *Leaves* alternate, distant, lamina pendent held at 45° on erect petioles; *petiole* concolorous with stem, in lower leaves c. 3–7 cm x 3–4 mm long, in upper leaves 1–1.5 cm x c. 2 mm long, terete; *lamina* variegated, margin silvery grey, veins dark green, lamina between veins either completely silvery grey to the base of the veins or with a few, large grey-green blotches, beneath uniform deep purple magenta, fleshy (brittle and snapping in live state), thinly chartaceous in dried state, glossy above, obliquely narrowly ovate, asymmetric, 11.5–16 x 7–8.5 cm, the broader side 5–5.5 cm wide, base cordate but not overlapping, basal lobes rounded, 4–5 cm long, margin slightly scalloped between veins and minutely serrulate, apex attenuate; venation palmate-pinnate, *midrib and lateral veins* 3–4, equal-sized, branching midway to margin, 2 veins in the basal lobe, slightly indented above, slightly prominent and concolorous beneath.

Plant protogynous. *Male inflorescence* produced after and in the same axil as a fruit or from the upper leaf axils, an erect, cymose panicle with third order branching, reddish brown or deep purple red, longer than subtending petiole, 4–15.5 cm long of which peduncle is 2.5–7.5 cm long; *bracts* pale green, ovoid, 6–9 x 5–6 mm, margin entire, apex acute, persistent. *Male flowers* with *pedicel* rosy red, 13–18 mm in open flower, very slender, *tepals* 4, pale rosy red deeper red towards centre, margin entire, outer two ± rotund, cucullate, 7–8 x 7–9 mm, glabrous, inner two oblong, apex rounded, 6–8 x 2–3.5 mm; *stamens* more than 40, cluster hemispherical, 3(–4) x 3(–4) mm including torus c. 0.5 mm long, *filaments* c. 0.75–1 mm long, *anthers* pale yellow, 0.75–1 mm long, apex emarginate. *Female flowers* solitary, produced at 1 or 2 (–3–4) successive leaf axils; *pedicel* c. 15–16 mm long; *ovary* deep rosy red, oblong, 16–24 x 15–22 mm, wings 3, equal, locules 3, paler, placentas axile, bilamellate with many ovules on both surfaces; *tepals* 5, outermost glossy, rosy red (paler than wings), broadly

oval c. 9—10 x 8—9 mm, innermost isomorphic and slightly smaller c. 7 x 6 mm, sometimes narrowly elliptic c. 8 x 4 mm, margin entire, apex rounded; styles 3, pale yellow, c. 4 mm long, joined at base for c. 1.5 mm, bifurcating; stigma papillose forming a continuous twisted band. Fruit dangling, pedicel drying to fine thread, 23—30 mm long, capsule broadly deltoid, 25—31 x 25—29 mm, glabrous, locules 3, dehiscing on upper half between locules and wing, wings 3, equal, 13—15 mm wide, very thin and fibrous, tip rounded; seeds brown, minute, ellipsoid, c. 0.3 mm long, truncate at base, rounded distally.

Distribution: Borneo – SABAH: Lahad Datu District, Tempadong and Batu Belas on Segama River and Tabin Wildlife Reserve.

Habitat: At base of cliffs, in crevices in rock face or on exposed shoulders of cliffs below tree canopy in light shade.

Notes: It is a typical member of sect. *Petermannia* in its erect cane-like habit, asymmetric leaves, in being protogynous with solitary female flowers produced before the distal, many flowered male inflorescences, in having a 3-loculate ovary with the placentation axile, bilamellate placentas, and the fruit having three equal wings and caducous style.

It most resembles *B. malachosticta* Sands in its habit and leaf shape but differs in the pattern of variegation (*B. malachosticta* has pink spotted leaves), much wider leaves (they are less than 5 cm wide in *B. malachosticta*), much branched male inflorescence (that of *B. malachosticta* is a simple cyme with three flowers or is once branched and just 4 cm long with about six flowers), larger male flowers (3—7.5 mm long in *B. malachosticta*) and the broader fruit with rounded wings (fruit is narrower, 10—17 mm wide, and has arcuate wings in *B. malachosticta*).

Local people eat the young, succulent shoots of this new species as a vegetable. Most begonia leaves have a sourish taste, but in Sabah relatively few are actively gathered for food. Another such esculent species, *Begonia lazat* Kiew & Reza Azmi, was discovered during the course of an ethnobotanical study (Reza Azmi and Kiew, 1998). The fact that species known to local people as food plants are still unknown to science indicates how little is still known about the begonia flora in Sabah.

This is a handsome begonia illustrated in Kee (2000) and Kiew (2000), which has lush, glossy leaves with silvery variegations on the upper surface and a deep magenta underside. It grows well on old porous coral in the nursery at Singapore Botanic Garden (Kee, 2000). That it adopts a pendulous habit when growing on the edge of cliffs indicates its potential for being grown in hanging baskets.

This new species is named for Andrea Kee, horticulturalist at Singapore Botanic Gardens, who was a member of the expedition that discovered this new species and who has carried out trials on its cultivation.

Specimens examined: SABAH: Lahad Datu District - Segama River - Batu Belas *Ruth Kiew et al. RK 4765* (SAN, SING); Tempadong the type: Tabin Wildlife Reserve *Ruth Kiew RK 5118* (SAN, SING, University of Sabah).

10. *Begonia keithii* Kiew

Section *Petermannia*

Kiew, Gardens' Bulletin Singapore 50 (1998) 189 & Fig. 4.

TYPE: Batu Tengar Cave *Kiew, Anthony & Lim RK4327* (holo SING; iso K, KEP, L, SAN, SAR).

Figure 5

Distribution: Borneo - SABAH: Semporna District, Batu Tengar Cave (Segarong Cave).

Habitar: In light shade or full sun, growing in crevices on the limestone hill, dominating exposed shoulders and summit of the hill, where it forms thickets with its woody cane-like stems, illustrated in Kiew (2000).

Notes: This is one of the most decorative of Sabah begonias with its polished red stems that give them a lacquered appearance, the dainty pointed leaves with a crimson scalloped margin and the many carmen, heart-shaped male buds set on slender sprays. It would be a fine addition to the cultivated begonias and, considering the harsh conditions under which it grows, would probably mean it is easier to cultivate than the forest species that grow in deep shade.

Specimens examined: SABAH: Semporna District - Batu Tengar Cave (Segarong Cave) *Symington & Agama 9312* (K, SING), *Keith A9416* (K, SING), *Kiew et al. RK 4327* (SAN, SING).

11. *Begonia lambii* Kiew, *sp. nov.*

Section *Petermannia*

A Begonia inostegia Stapf foliis dense hirsutis obovatis brevipetiolatis et fructibus oblongis differt — TYPUS: Batu Tinahas R. *Kiew & S. Anthonymsamy RK 4405* (holo SAN; iso K, SING).



Figure 5. *Begonia keithii* Kiew

A Habit x 1/2, B & C Branchlet of male inflorescence x 1/2 and x 1, D Male flower bud x 1 1/2, E Male flower x 1 1/2, F. Androecium x 5, G Stamen x 10, H Female flower x 1, I Open female flower x 1 1/2, J Style and stigma x 5, K T.S. ovary x 2, L Fruit x 1. (from RK 4327)

Figure 6

Rosette herb with 3—4 leaves held $\pm$ flat on the leaf litter layer. Stem and petioles with brown and scurfy indumentum giving a felted appearance with additional sparse long hairs. *Stem* unbranched, becoming woody, erect, to 10—13 cm tall and 3—5 mm diam., internodes 1.25—2.5 cm long. *Stipules* pale green, lanceolate, c. 14 x 14 mm, margin entire, midrib keeled, apex cuspidate, caducous. *Leaves* alternate, distant, held horizontally; *petiole* 1—2.5 cm, shallowly grooved above; *lamina* plain dark green above, green or reddish brown or maroon beneath, hairs on upper surface upstanding, eglandular, uniseriate, c. 1.5 mm long, translucent in completely green leaves, reddish brown, purple or magenta where lamina is coloured beneath, glabrous beneath, thin, matt, broadly obovate, strongly asymmetric, 12—14.5 cm x 7.5—11 cm, narrower side slightly concave, broader side 5—7.5 cm wide rounded, base unequally cordate, basal lobe 1—3 cm long, margin denticulate with each tooth tipped by long hair, apex rounded or shortly acuminate (acumen 4—5 mm long); venation palmate, *midrib and veins* brown or deep purple and densely hairy beneath, 5—7 veins, midrib $\pm$ same size as the laterals, branching dichotomously 3—4 times before reaching margin, c. 3 veins in larger basal lobe, veins deeply impressed above giving the lamina a corrugated appearance.

Inflorescence protogynous, from axil of new leaf, densely hairy, erect, longer than petioles, at first compact and cymose 1—3 cm long with one female flower, then producing a spike 7.5—10 cm long of distant cymules with crowded male flowers, peduncle 1.25—2.5 cm; *bracts* pale green, narrowly lanceolate, 5 x 1.5 mm, entire, persistent. *Male flower* with white *pedicel* 4—5 mm long, densely hairy; *tepals* 2, pure white, densely hairy on outer convex central portion, broadly elliptic, 5—9 x 4.5—8, entire, apex rounded; *stamens* c. 30, cluster conical, 2—3.5 x 3—3.5 mm, usually sessile, *filaments* 0.5—0.75 mm long, *anthers* obovate, c. 1.5 x 0.75 mm, apex not emarginate. *Female flower*: *pedicel* c. 4—7 mm long, white, densely hairy; *ovary* green, sparsely hairy on the wings, densely hairy on the locules, oblong with wings expanding slightly distally, 5—9 x 3—8 mm, wings 3, reddish, isomorphic, wings c. 1—2 mm wide, locules 3, placentas bilamellate; *tepals* 5, white, outer surface with long hairs, $\pm$ isomorphic, innermost slightly narrower, elliptic, 9—12 x 5—8 mm in outer 4 tepals and 4—5 mm wide in innermost tepal, entire, apex acute; *styles* 3, greenish, c. 4 mm long, joined for c. 1 mm at base, distally bifurcating, *stigma* papillose forming a continuous twisted band. *Fruit* decurved and pendent, pedicel rigid, 1—2 cm long, capsule oblong, rounded at base, truncate or rounded at apex, 15—18(—25) x 10—13(—14) mm, hispid particularly on locules, style caducous, locules 3, dehiscing between locule and wing, wings 3, equal.

thin, 2—4 mm wide; *seeds* brown, minute, broadly ellipsoid, c. 0.2—0.25 mm long, tapered to base, rounded distally.

Distribution: Borneo – SABAH: Pensiangan District, Batu Punggul and Batu Tinahas; Sapulut.

Habitat: Steep earth slopes up to or on flat areas at the base of limestone cliffs.

Notes: The species is striking in several respects. Its deeply corrugate, obovate leaves with a dense covering of magenta or purple hairs contrasting with the dark green lamina make it a distinctive species. Its habit too, where the dark green leaves lie on and blend with the leaf litter, is also unusual. It is illustrated in Kiew (1998d, 2000).

It is a typical member of Section *Petermannia* in having an upright habit, being protogynous, the female flowers having 5 sepals, a 3-loculate ovary with bilamellate placentas, the male flowers having 2 tepals, obovate anthers that are not emarginate, and the capsule having 3 isomorphic wings and caducous styles.

In inflorescence structure, it is closely similar to *B. inostegia* Stapf from Gunung Kinabalu. Both at first have a short inflorescence, which produces the single female flower, as this matures into the fruit, an erect axis is produced with a few distant, short lateral branches that produce bunches of crowded male flowers. The inflorescence is thus protogynous and the single female flower is basal to the many male flowers. However, the leaves of these two species are very different, those of *B. inostegia* are long-petioled, ovate with a cuspidate apex, and the capsule is obovoid. In addition, *B. lambii* also does not have the peculiar ovate, fimbriate stipules characteristic of *B. inostegia*.

This decorative species is named for Anthony Lamb of the Agricultural Park, Sabah, whose deep interest in Sabah plants has inspired him to bring this species (and many others of horticultural potential) into cultivation.

Specimens examined: SABAH: Pensiangan District - Batu Punggul *Ali Ibrahim* AI 135 (SING), *Sunbing Jinpin* SAN 135991 (SAN), Batu Tinahas the type and *R. Kiew & S. Anthonysamy* RK 4408 (K, SAN, SING); Sapulut (near Kampung Naaturan) *R. Kiew & S. Anthonysamy* RK 4345 (SING). It is also cultivated at the Agricultural Park, Tenom.

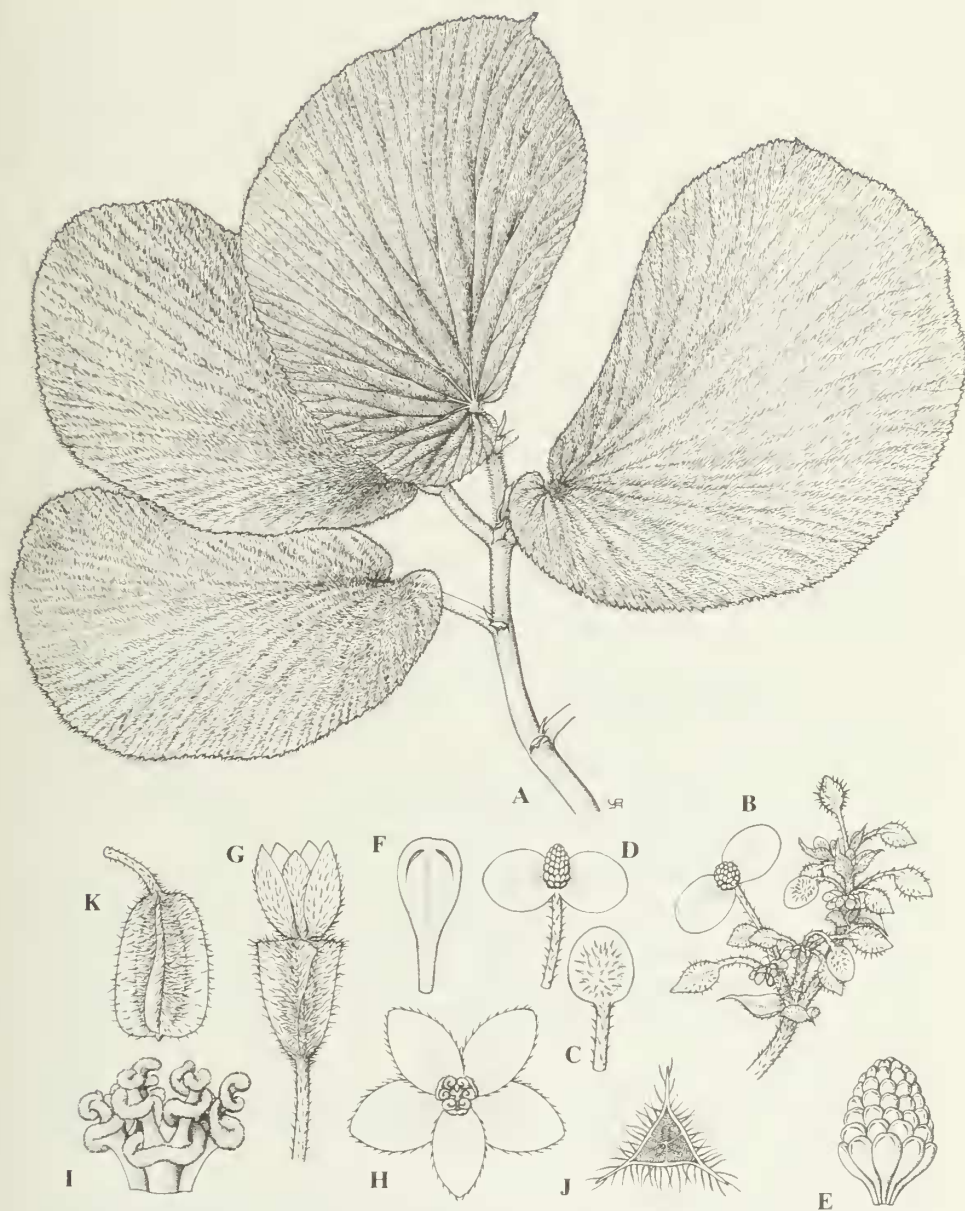


Figure 6. *Begonia lambii* Kiew

A Habit x $\frac{1}{2}$, B Male inflorescence x 1, C Male bud x $\frac{3}{4}$, D Open male flower x 1, E Androecium x 4, F Stamen x 10, G Female flower x 1, H Open female flower x 1, I Style and stigma x 4, J T.S. ovary x $1\frac{1}{2}$, K Fruit x 1. (from RK 4408)

12. *Begonia layang-layang* Kiew, *sp. nov.*

Section *Petermannia*

A Begonia amphioxo Sands foliis latoribus et fructibus majoribus pedicello longiore suffultis — TYPUS: Sapulut R. Kiew & S. Anthonysamy RK 4441 (holo SAN; iso BRUN, K, L, SAR, SING)

Cane-like, glabrous begonia. *Stem* pale green at first, becoming brown, c. 1 m tall and 3–6 mm diam., woody, internodes up to 4 cm long, erect, branching dichotomously, young branches conspicuously zigzag, nodes annular. *Stipules* pale green, narrowly lanceolate, to 12–14 x 2–4 mm with prominent midrib, margin entire, apex acute, caducous. *Leaves* alternate, distant, pendent; *petiole* pale green, (2.5–)3.5(–5.5) cm and in dried state 1 mm thick, slightly grooved above; *lamina* plain dark green above except for the red patch at point of attachment with petiole, pale green or sometimes reddish beneath, succulent drying slightly leathery, slightly glossy above, peltate, slightly asymmetric, narrowly elliptic, (8–)10(–11.5) x (2–)2.2(–4.5) cm, the broader side (1.7–)2(–2.7) cm wide, basal lobe acute to pointed sometimes slightly oblique, length of basal lobe (3.5–)4.2(–5.5) cm, margin red with fine distant teeth becoming closer and more prominent towards apex, apex attenuated; venation palmate-pinnate, *midrib and lateral veins* concolorous with lamina, 1–4 unbranched pairs, 3 veins in basal lobe, plane above, slightly prominent beneath.

Plant protogynous. *Male inflorescences* from upper leaf axils, green, erect, longer than petioles, a slender, lax three times-branched panicle with c. 15 flowers, 3.7–5.2 cm long of which peduncle is 2.2–3.7 cm; *bracts* lanceolate, thin, green, lower ones c. 12 x 3 mm, becoming smaller towards stem apex, midrib prominent, margin entire, caducous. *Male flowers* with whitish *pedicel* (3–)5–7 mm long, *tepals* 4, outer two pinkish outside, white inside, glabrous, subrotund, c. 6 x 5.5 mm, entire, apex rounded, inner two white, narrowly elliptic, c. 5 x 1.75 mm, apex rounded; *stamens* over 50, cluster conical, sessile, c. 3 x 2.5 mm, *filaments* c. 1–1.25 mm, *anthers* golden yellow, obovate, c. 0.75–1 mm long, apex emarginate. *Female flowers* solitary (rarely 2 per axil) in lower leaf axils; *pedicel* 17–27 mm long; *ovary* deltoid, 17–27 x 19–30 mm, wings 3 equal reddish, c. 4–8 mm wide, locules 3, placentas axillary, bilamellate with many ovules on both surfaces; *tepals* 5, free, greenish white, outer four broadly elliptic, slightly tapered to base, 9–15 x 5–9 mm, entire, apex rounded, inner one narrower, slightly obovate, 10–12 x 4–5 mm, apex rounded; *styles* 3, dark yellow, 4–5 mm joined for c. 1.75 mm at base, distally bifurcating; *stigma* papillose forming a continuous twisted band. *Fruit* dangling, pedicel extremely fine, (1.3–)2.8(–3.7) cm, capsule broadly deltoid, distal edge straight, (20–)

24.5(—29) x (22—)26(—33) mm. locules 3, dehiscing between upper half of wing and locule, wings 3, isomorphic, rounded proximally, truncate distally, 7(—8) mm wide, thinly fibrous, style caducous; *seeds* brown, minute, broadly ellipsoid, c. 0.3 mm long, base narrowed, rounded distally.

Distribution: Borneo – SABAH: Pensiangan District, Sapulut.

Habitat: In shade below tree canopy on rocks at base of cliff and on subsummits.

Notes: It is a typical member of sect. *Petermannia* having a cane-like habit, being protogynous and having fruits with three equal wings and a caducous style.

In its peltate and relatively narrow leaves, it most resembles *B. amphioxus*. However, it is clearly distinct from this species in its non-variegated leaves (those of *B. amphioxus* are red spotted), which are broader and less than four times longer than wide (compared with 8—28 mm wide and at least five times longer than wide in *B. amphioxus*), the tepals of the female flower are always free (frequently joined in *B. amphioxus*), and the much larger fruits on long pedicels with three broad equal wings. The fruits of *B. amphioxus* are smaller, 9—13 x 5—14 mm, frequently are two-winged, the wings are only 2—5 mm wide and the pedicels 2—2.5 cm long. (Sands, *pers. comm.*, informs me that 2—2.5 mm given as pedicel length in his type description is in error and should read 2—2.5 cm).

Both *B. layang-layang* and *B. amphioxus* grow in moderate shade on rock faces quite close to the base of the cliff. In this they differ from *B. baturongensis*, *B. keithii* and *B. madaiensis* that grow fully exposed or in light shade and do not flower in deep shade.

This species takes its name from the local one, *layang-layang* meaning swallow in Malay, because of the resemblance of the leaf shape to a swallow's wings. It is illustrated in Kiew (1998d) as 'the swallow begonia'.

Specimens examined: SABAH: Pensiangan District - Sapulut (near Kampung Labang) the type and *Diwol Sundaling* SAN 13522 (SAN), *Aban & Singh* SAN 107961 (SAN).

13. *Begonia madaiensis* Kiew, *sp. nov.*

Section *Petermannia*

A *Begonia baturongensi* Kiew fructibus longioribus quam latioribus apice acutis — TYPUS: Gunung Madai R. Kiew *et al.* RK 5057 (holo SAN: iso K. SAR, SING).

Figure 7

Cane-like, glabrous begonia with several stems arising from prostrate rhizome. *Stem* reddish brown when young, at first erect, then becoming prostrate or pendent if growing on cliffs, to 1.7 m tall x 4–10 mm diam., internodes 3.5–10 cm long, woody, slightly thicker at nodes much branched, twigs zigzag to 60 cm long, maroon. *Stipules* pale rosy purple, narrowly lanceolate, c. 20–21 x 5–6 mm, margin entire, midrib keeled, apex attenuate, caducous. *Leaves* alternate, distant, pendent; *petiole* maroon, 1.2–5 cm x 1–3 mm long, terete; *lamina* green, dark green or brown-green, beneath maroon or pinkish light green, margin red, veins red above and beneath, young leaves variegated above with oval whitish-green or silvery spots of varying size between the veins, sometimes coalescing, and with tiny spots along the margin, veins deep ruby red above and rosy purple beneath, expanding leaf strongly pleated, succulent and brittle in live state, membranous when dried, surface slightly scintillating and appearing finely velvety, obliquely ovate, asymmetrical, (5–)10(–13.5) x (1.7–)4(–6) cm, the broader side being (1–)2.2(–3.2) cm wide, basal lobe broadly rounded (1.2–)2.5(–5) cm long, margin scalloped, apex acuminate; venation palmate-pinnate, *midrib and lateral veins* red beneath, (2–)3 veins branching c. midway to the margin with (1–)2 veins in the basal lobe, plane above, slightly prominent beneath.

Plant protogynous. *Male inflorescences* about 5 produced from upper axils, brownish red, erect, slightly longer than petioles, once-branched cyme with up to 7 flowers, 3.7–4 cm long of which 2–2.7 cm is the peduncle; *bracts* narrowly lanceolate, c. 12–14 x 3 mm, caducous. *Male flower* with pink *pedicel* 7–9 mm; *tepals* 4, outer two white or rosy pink, glabrous, subrotund, (5–)7(12) x (6–)7(–9) mm, margin entire, apex rounded, inner two pure white, narrowly obovate, 6–7 x 2 mm, margin entire, apex rounded; *stamens* c. 40, cluster broadly ovoid, sessile, c. 4 x 3 mm, *filaments* 0.5–0.75 mm, *anthers* golden or pale yellow, obovate, c. 1 mm long, apex emarginate. *Female flowers* solitary from lower leaf axils, up to 5 produced; *pedicel* 9–11 mm long, pale red; *ovary* pale green-white with edge of wings reddish, oblong, c. 11–12 x 9 mm, wings 3, equal, locules 3, placentas axile, bilamellate with many ovules on both surfaces; *tepals* 5, white faintly pink towards edge, elliptic, margin entire, apex acute, isomorphic, the inner slightly narrower, outer four c. 9 x 6 mm, inner one c. 9 x 4 mm; *styles* 3, yellowish green or golden yellow, 4 mm long joined for c. 0.5 mm at base, bifurcating; *stigmas* papillose forming a continuous twisted band. *Fruit* pedicel withering and becoming thread-like so the fruit dangles, (6–)14(–20) mm long, capsule obovate, (17–)25(–29) x (10–)18(–20) mm, glabrous, locules 3, dehiscing between locule and wing in the upper half of

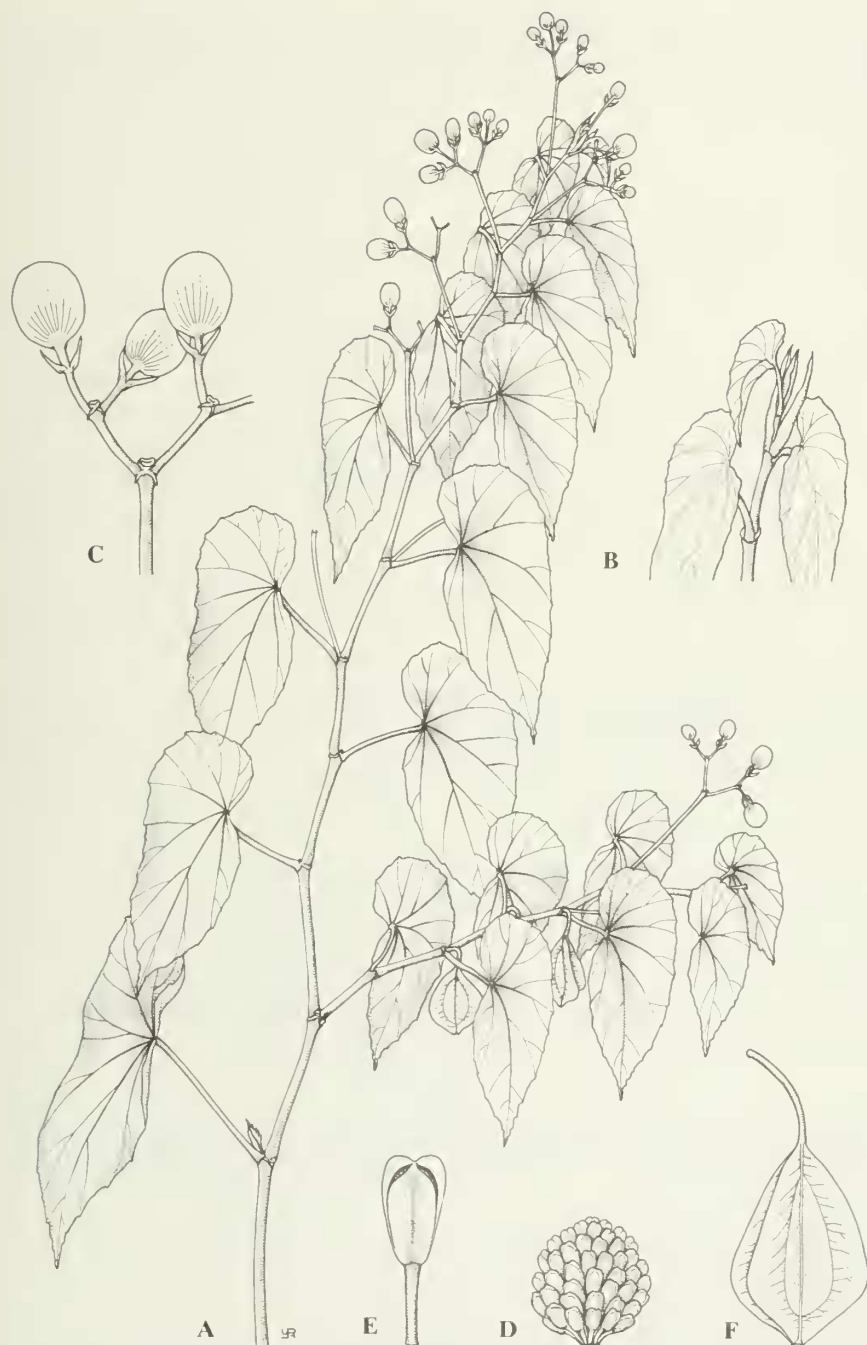


Figure 7. *Begonia madaiensis* Kiew

A Habit x $\frac{1}{2}$, B Stipules x 1, C Branchlet of male inflorescence x 2, D Androecium x 5, E Stamen x 15, F Fruit x 1. (from LSP 672)

capsule, wings 3, equal, rhomboid, (3—)5(—7) mm wide, thinly fibrous; seeds brown, minute, broadly ellipsoid, c. 0.25—0.3 mm long, base truncate, distally rounded.

Distribution: Borneo – SABAH: Lahad Datu District, Gunung Madai.

Habitat: Growing directly on limestone rocks and cliff faces in light shade.

Notes: In its erect habit, being protogynous with solitary female flowers below and male inflorescences above, in the 3-loculate ovary with bilamellate placentas and capsule with 3 equal wings and a caducous style, it is typical of sect. *Petermannia*. However, the male flowers have four tepals.

Among the cane-like begonias on limestone in Sabah, *B. madaiensis* is most similar to *B. baturongensis* in their leaves being broader and having a rounded basal lobe compared with those of *B. amphioxus* and *B. keithii*, and in being smaller than those of *B. heliostrophe*, *B. keana* and *B. malachosticta*. *B. madaiensis* can easily be told apart from *B. baturongensis* by its fruit, which narrows to the apex, giving it a rhomboid outline. Besides fruit shape, it also differs from *B. baturongensis* in several other features, such as its scalloped leaf margin, smaller bracts, less branched male inflorescence, white or pale pink flowers, tepals of the male flower that are longer than broad, and the leaves, which are strongly pleated before they expand.

The leaves of young plants are larger (about twice the size of those on fertile shoots) and can be conspicuously variegated, but this coloration is not expressed in older leaves. Plants growing in deeper shade tend to have greener, less maroon leaves and plants in deep shade, i.e. at the base of cliffs, do not flower. Flowering on a single twig is effectively unisexual as the female phase does not overlap with the later male phase.

Specimens examined: SABAH: Lahad Datu District - Gunung Madai the type and W. Meijer SAN 37950 (SAN), SAN 37959 (SAN), S.P. Lim et al. LSP 672 (SAN, SING), LSP 702 (SAN, SING).

14. *Begonia malachosticta* Sands

Section *Petermannia*

Sands, Kew Magazine. 7 (1990) 64 & Plate 145.

TYPE: Bukit Dulong Lambu Sands & Young - Sands 3933 (not seen)

Distribution: Borneo – SABAH: Kinabatangan District, Bukit Dulong Lambu (Gomantong Cave).

Habitat: In rocky crevices in the sheer cliffs where the tree canopy begins to open up, as well as on exposed jagged outcrops. It is no longer common on the summit, which is greatly disturbed by the village of birdnest collectors that is established on the summit plateau.

Notes: This is a strikingly beautiful species with pink spotted leaves with a red underside. It has been introduced into cultivation at Kew where it is grown in a 50:50 mix of peat and sand. It is propagated easily from nodal cuttings (Sands, 1990).

It is eaten as a vegetable but is reportedly very sour (*Kamideh SAN 66578*).

Specimens examined: SABAH: Kinabatangan District - Bukit Dulang Lambu (Gomantong Cave) *James Ah Wing SAN 38108* (SAN), *SAN 47263* (SAN); *Kamideh Bangillan SAN 66578* (SAN).

15. *Begonia melikopia* Kiew, *sp. nov.*

Section *Petermannia*

A Begonia erythrogyna Sands foliis latioribus, inflorescentiis minoribus, tepalis rubris et fructibus angustioribus differt — TYPUS: Gua Melikop *Ruth Kiew et al. RK 5011* (holo SAN; iso BRUN, K. L. SAR, SING).

Cane-like, glabrous begonia with prostrate rhizome with several spaced erect stems to 1.5 m tall x 5—7 mm diam., base becoming woody, young stems brittle at swollen nodes, reddish above nodes, otherwise green, leaf scars very conspicuous, internodes 2.5—5.5 cm long, slightly ribbed, stems with 1—2 branches. *Stipules* green, strongly keeled, lanceolate, 23—25 x 9—11 mm, margin entire, apex acute, caducous. *Leaves* alternate, distant, in a bunch at top of stem, held horizontally; *petiole* completely reddish or reddish proximally and distally but green in between, 8.5—13 cm x 4—6 mm, grooved above; *lamina* plain mid-green above, beneath completely magenta or with magenta blotches and green veins, seedling leaves with white spots, succulent and brittle in life, thinly chartaceous in dried state, glossy above, asymmetric, broadly ovate, sometimes almost reniform, 15—19.5 x 12—18.5 cm of which broader side is 7.5—11.5 cm wide, basal lobes broadly rounded, 3.5—7.5 cm long, base cordate but not overlapping, margin scalloped between veins and minutely and distantly dentate, apex cuspidate; venation palmate-pinnate, *midrib and lateral veins* concolorous with lamina above, 5—7 pairs, branching twice dichotomously, first less than halfway to margin, then c. halfway to margin, 1—2 veins in basal lobe, impressed above, prominent beneath.

Inflorescence axillary, protogynous with 2 female flowers at base of the erect cymosely branched panicle of male flowers, shorter than petioles, 6—7.5 cm long of which peduncle is 1.7—2.5 cm with diam. c. 2 mm, branching c. 3—4 times, c. 4—8 main branches 4—15 mm long, ultimate branches 8—20 mm long, knobbly from congested scars of fallen flowers, each terminating in 1 bud or 1 bud and 1 one flower. *Male flower* with slender *pedicel* 7—12 mm long, *tepals* 2, flame-coloured darker towards base, glabrous, oval, 8—11 x 4—5 mm, margin entire, apex rounded; *stamens* c. 25, cluster conical, 3.5—4 x 2.5—3 mm, sessile, *filaments* c. 0.75 mm long, *anthers* pale yellow, spatulate, c. 1.2 mm long, apex not emarginate. *Female flower* not known. *Fruit* pendent and dangling on fine and thread-like pedicel 25—38 mm long, capsule narrowly deltoid narrowed into pedicel, 40—55 x 10—27 mm, glabrous, locules 3, placentas axile, bilamellate with many seeds on both surfaces, dehiscing between wing and locule, wings 3, equal, 6—7 mm wide, becoming thin and papery, tip acute or sometimes rounded; *seeds* brown, minute, almost globose, c. 0.2 mm long, base tapered, rounded distally.

Distribution: Borneo: SABAH – Kinabatangan District, Gua Melikop.

Habitat: Gua Melikop is an exposed cliff face on a hillside at about 400 m altitude. Its summit is covered by a deep layer of peat, which does not support a limestone flora.

Begonia melikopia grows rooted in cracks in the sheer limestone rock face in deep shade below the canopy but c. 1.5—2 m above base of limestone cliff. (Some seedlings were found growing in soil near the base of the cliff but no adult plants were found on soil, suggesting that these seedlings might not survive to maturity).

Notes: In its large, broadly ovate leaves, paniculate male inflorescence and large deltoid fruits pendent on long pedicels, it resembles *B. erythrogyna* Sands. However, it is distinct from this species in its much broader leaves (those of *B. erythrogyna* are less than 16 cm wide), its shorter, axillary male inflorescence (terminal and 7—14 cm long in *B. erythrogyna*), the male flowers are flame-coloured (they are white to pale green in *B. erythrogyna*), and the fruit, which is more than twice as long as wide (in *B. erythrogyna* it is less than twice as long as wide).

Begonia melikopia is typical of sect. *Petermannia* in its cane-like habit, in being protogynous, having male flowers with two tepals, and the fruits with three equal wings and three locules each with bilamellate placentas.

Specimens examined: Known only from the type population.

16. *Begonia postarii* Kiew

Section *Petermannia*

Kiew, Gardens' Bulletin Singapore. 50 (1998) 165 & Fig. 1.

TYPE: Bukit Panggi Kiew & Lim RK 4221 (holo SAN; iso SING).

Figure 8

Distribution: Borneo – SABAH: Kinabatangan District, Kinabatangan Valley (Bukit Panggi, Bukit Dulong Lambu (Gomantong Cave) and Subuk Estate).

Habitat: At base of limestone hills (but not on cliff faces) growing in deep shade in sheltered damp habitats on soil, low limestone boulders or the base of tree trunks.

Notes: This softly hairy begonia with hairy tepals in the male flower and the hairy fruit is quite unlike any other limestone species in Sabah.

Specimens examined: SABAH: Kinabatangan District - Bukit Dulong Lambu Joseph B. et al. SAN 122763 (SAN), Lim S.P. & Ubaldus LSP 802 (SAN, SING), Ruth Kiew & Lim S.P. BDL 4 (K, SAN, SAR, SING); Bk. Panggi Ruth Kiew & Lim S.P. RK 4221 (SAN, SING); Subak Estate (Lower Kinabatangan River) J. Dransfield et al. JD 5770 (SAN).

17. *Begonia punbatuensis* Kiew, *sp. nov.*

Section *Petermannia*

A *Begonia burbridgei* Stapf fructibus minoribus, pedicellis filiformibus 2.5–3 cm longis differt — TYPUS: Pun Batu R. Kiew & A. Berhaman RK 4260 (holo SAN; iso BRUN, K, L, SAR, SING).

Figure 9

Cane-like begonia. *Stem* robust, dark brown, up to 1.3 m tall and 6 mm diam., erect, little branched, woody, internodes up to 4–5.5 cm long, nodes conspicuously swollen with conspicuous leaf scars, eglandular uniseriate hairs c. 0.5–0.75 mm long, scattered on the young stem, becoming glabrescent. *Stipules* pale green, glabrous except for a few scattered hairs on the outer surface of the midrib, slightly obovate, 2–3.5 x 1–1.3 cm, margin entire, apex acute, persistent. *Leaves* alternate, distant; *petiole* green with brown bristly hairs, 2.5–6 cm long, grooved above; *lamina* plain mid-green above and beneath except for crimson patch on upper surface at the junction with the petiole, succulent and brittle in life, thinly leathery in

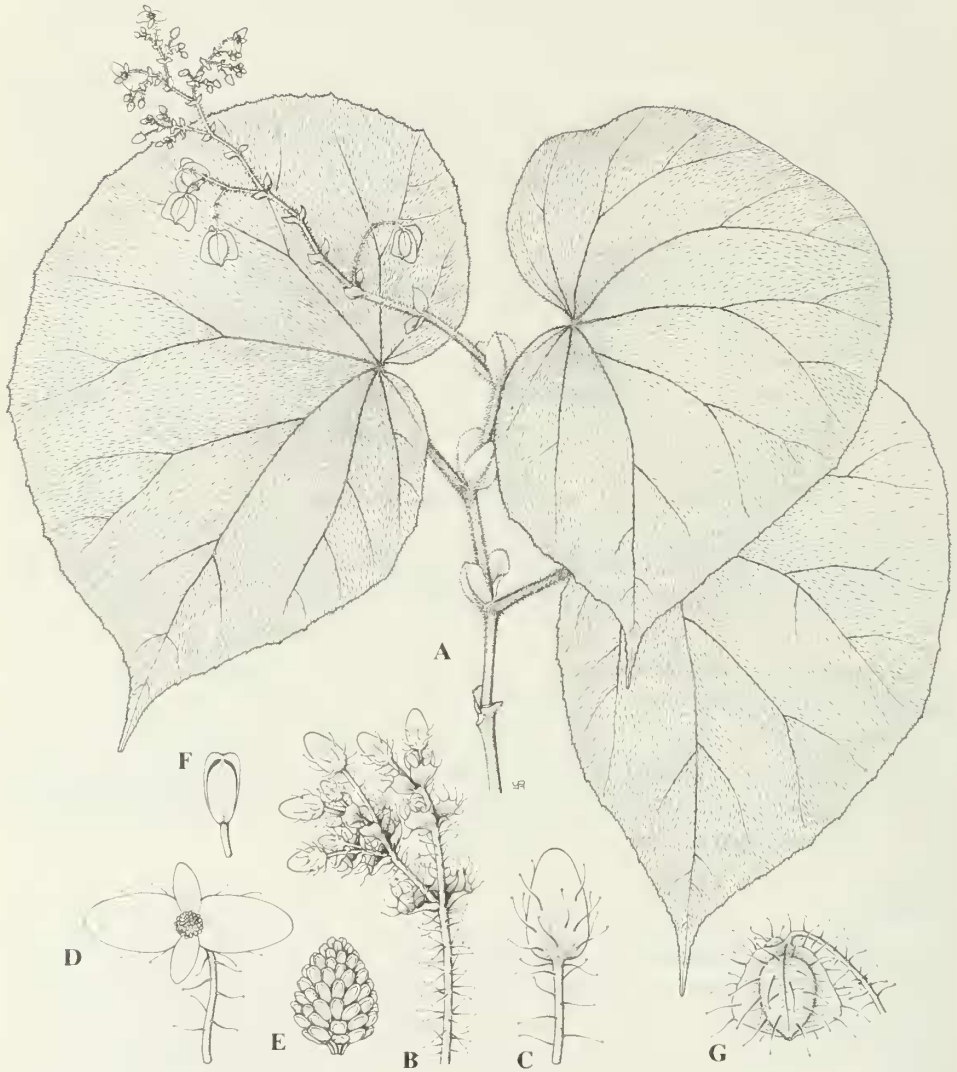


Figure 8. *Begonia postarii* Kiew

A Habit $\times \frac{1}{3}$, B Branchlet of male inflorescence $\times 1\frac{1}{2}$, C Male bud $\times 1$, D Male flower $\times 2$, E Androecium $\times 4\frac{1}{2}$, F Stamen $\times 8$, G Fruit $\times 1$. (from RK 3838)

dried state, glossy above, obliquely ovate, strongly asymmetric, 5—9 x 6—10 cm, narrow side lanceolate, broad side broadly ovate 4.5—7 cm wide, base cordate, not overlapping, basal lobe 1.7—4 cm long, margin shallowly dentate, faintly red in young leaves, apex acute; venation palmate, *midrib and lateral veins* concolorous with lamina, sparsely hairy beneath, 3—4, $\pm$ equal-sized, branching dichotomously twice before reaching the margin, first close to petiole, second towards the margin, 1 vein in basal lobe, plane above, prominent beneath.

Inflorescences protogynous, in the axils of upper leaves, pale green, glabrous, $\pm$ erect, longer than adjacent petiole, cymose, with up to 4 inflorescences at successive leaf axils, each branched at base, one axis with 2 female flowers on peduncle 2.5—3 cm long, the other axis bears the male inflorescence with c. 4 lateral branches, conspicuously jointed, 5.5—9 cm long of which peduncle 3.2—4.5 cm long; *bracts* pale green, obovate, those at base c. 20 x 15 mm, those subtending male flowers c. 10 x 9 mm, persistent. *Male flowers* with whitish green, glabrous *pedicel* 17 mm long; *tepals* 4, rosy or pale pink, glabrous, outer two broadly oval, 14 x 13 or 15 x 10 mm, inner two narrowly elliptic, c. 9 x 5 mm, margin entire, apex rounded; *stamens* c. 50, cluster conical, sessile, 9 x 4 mm, *anthers* subsessile, golden yellow, narrowly oblong, c. 2 x 1 mm, apex emarginate. *Female flower* with pale green, glabrous *pedicel*; *ovary* pale greenish white, glabrous, ovoid, 15 x 15—17 mm, wings 3, isomorphic, 3 locules, placentas axile and bilamellate with many ovules on both surfaces; *tepals* 5, pale rosy pink, broadly elliptic, outer 17 x 10 mm, inner 14 x 7 mm margin entire, apex slightly acute; *styles* 3, golden yellow, c. 5—6 mm long, bifurcating; *stigma* papillose forming a continuous twisted band. *Fruits* pendent, dangling on fine, thread-like *pedicel* 2.5—3 cm long, *capsule* 17—22 x (12—)20—28 mm, glabrous, locules 3, dehiscing between upper half of locule and wing, wings 3, isomorphic, truncate distally (4—)6—7 mm wide, thinly fibrous; *seed* brown, minute, ellipsoid, c. 0.5 mm long, base truncate, distally rounded.

Distribution: Borneo – SABAH: Keningau District, Pun Batu.

Habitat: Summit of the limestone hill growing on exposed peat-covered rocks.

Notes: Pun Batu is an isolated tower karst hill and its summit is covered in a deep peat layer. Its unique begonia grows in this habitat and as yet has not been found on any other limestone hill. The surrounding forests are actively being logged but when we visited in 1996, its surrounding foothills were still pristine.

In its upright habit, in being protogynous, and with the fruit being 3-

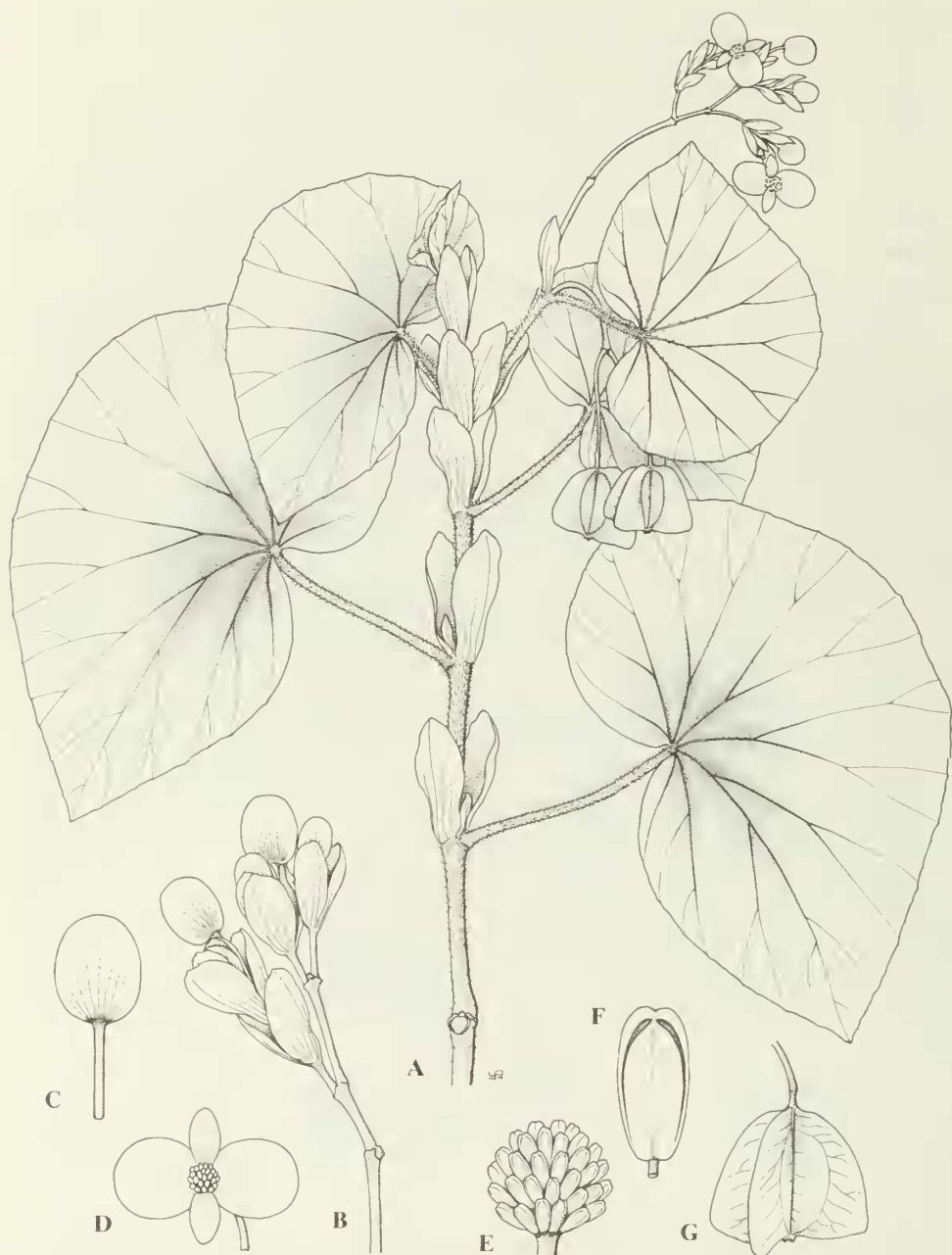


Figure 9. *Begonia punbatuensis* Kiew

A Habit x $\frac{1}{2}$, B Branchlet male inflorescence x 1, C Male bud x $\frac{1}{2}$, D Male flower x 1, E Androecium x 3, F Stamen x 10, G Fruit x 1. (from RK 3898)

loculate with three equal wings and a bilamellate placenta and caducous style, it falls within sect. *Petermannia*.

Begonia punbatuensis resembles *B. burbridgei* from Gunung Kinabalu in its robust, woody stems with swollen nodes, large stipules on the young stems and in its leaf shape and venation. However, *B. burbridgei* is a larger plant growing to c. 2–2.7 m tall, its leaf apex is acuminate to cuspidate, its inflorescences have larger bracts, the male flowers have much larger tepals (the outer two tepals measuring c. 25 x 20 mm), and the fruits are also much larger (up to 27 x 46 mm), the wings are not truncate and the fruit stalk is stiff and short (c. 15 mm long).

Although its bracts are quite conspicuous, *B. punbatuensis* does not belong to sect. *Bracteibegonia* sensu Doorenbos *et al.* (1998), which includes just three species from Java and Sumatra. These differ from species in sect. *Petermannia* in having pinnate venation, few flowered bisexual inflorescences and persistent styles in the fruit. Doorenbos *et al.* therefore transferred the Bornean species with conspicuous bracts, previously placed in sect. *Bracteibegonia* (such as *B. burbridgei* Stapf and *B. imbricata* Sands), to sect. *Petermannia*, to which they conform in their venation, inflorescence structure and caducous style.

Specimens examined: SABAH: Pensiangan District – Pun Batu the type and Ruth Kiew & A. Berhaman RK 4279 (E, KEP, SAN, SING).

18. *Begonia urunensis* Kiew, *sp. nov.*

Section *Petermannia*

A *Begonia anthonyi* Kiew and *B. berhamanii* Kiew caulibus ramosis, foliis latoribus et inflorescentiis masculis paniculatis differt — TYPUS: Batu Urun R. Kiew & S. Anthonyamy RK 4473 (SAN, SING).

Low, erect, bushy herb, trichomes uniseriate c. 0.5 mm long, dense on young stems, stipules, petioles, lower surface of veins, inflorescence and pedicels, sparse on lamina. *Stem* to 33 cm tall and 5–7 mm diam., woody towards the base, lowermost internodes 4.5–10 cm long, lower nodes swollen, upper internodes 3–4.5 cm long, producing short branches which sometimes branch again. *Stipules* lanceolate, 5.5–17 x 2.5–3.5 mm, margin entire, apex attenuate to setose, caducous. *Leaves* alternate, distant, towards apex some leaves subopposite; *petiole* 6–15 mm long in lower leaves, 4–7 mm in the upper; *lamina* plain mid-green above, (12.5–)15–(15.5) x (5–)6.5–(8) cm, slightly succulent in life, papery when dry, obovate, sometimes rhomboid and widest midway, slightly asymmetric, narrow side concave towards the base, broad side rhomboid, 3–4.2 cm wide, base unequally

cordate, basal lobe 2.5—7.5 mm long and auriculate, margin minutely and distantly dentate, apex narrowly attenuate; venation pinnate, *lateral veins* 6—7 pairs, branching once, sometimes twice before reaching the margin, 1 vein in basal lobe, prominent above and beneath.

Plant protogynous with 2 female flowers and a male inflorescence from each of upper leaf axils. *Male inflorescence* erect, 0.8—2.5 cm long of which peduncle is to 1 cm long longer than petioles, central axis with several tiers of three times branched side branches c. 7 mm long; *bracts* lanceolate, c. 7 x 2 mm, margin entire, apex setose, caducous. *Male flowers* with *pedicel* 3—5 mm long; *tepals* 2, pinkish, densely hispid outside, elliptic, c. 5 x 3.5 mm, margin entire, apex rounded; *stamens* c. 40—50 in conical, sessile cluster; *filaments* c. 0.5 mm long; *anthers* orange, spatulate, c. 0.75 mm long, apex not emarginate. *Female flower* not known. *Fruit* with decurved, stiff pedicel (4—)7(—9) mm long; capsule broadly oblong, (14—)18(—21) x (15—)17(—19) mm, glabrous, locules 3, placentas axile, bilamellate with many seeds on both surfaces, dehiscing along entire length between locule and wing, wings 3, isomorphic, tip rounded, (4—)6(—7) mm wide, thinly fibrous; *seed* brown, minute, broadly ellipsoid, c. 0.2 mm long, base truncate distally rounded.

Distribution: Borneo – SABAH: Pensiangan District, Batu Urun.

Habitat: Deeply shaded forest on soil on steep slopes up to and at the base of limestone.

Notes: Its erect habit, three locular ovary and fruit with three equal wings place this species within sect. *Petermannia*. Among the limestone species, it groups with *B. anthonyi* and *B. berhamanii*, which are short begonias with bristly stems, their leaves are only slightly asymmetric, the petioles short and the midrib more or less in line with the petiole, the male flowers have two tepals, and the fruits do not have long, thin, thread-like pedicels. However, it is not typical of this group of begonias in two respects. Firstly, it differs in habit. In *B. urunensis*, the stem branches once or sometimes twice to produce flat sprays of leaves giving it a bushy appearance. (The stems of *B. anthonyi* and *B. berhamanii* are unbranched). Secondly, the male inflorescences are produced from the same leaf axil as the female flowers and are erect and paniculate, whereas in *B. anthonyi* and *B. berhamanii*, the female flowers are produced from the lower axils and the short, spicate male inflorescence from the upper. *B. urunensis* can also be told apart from these two species by its broader leaf, which is less than 2.5 times longer than broad as compared with 2.7—4 and 5 times, respectively for *B. anthonyi* and *B. berhamanii*.

Batu Urun is one of the most remarkable limestone formations in Sabah being unique in its cave, which has its mouth on the side of a deep and wide basin below soil level. From the mouth of the cave a dangerously steep scree slopes precipitously down to a subterranean river, which to judge from the large tree trunks lodged in it carries strong currents in rainy weather. On one side of the basin is a vertical wet cliff face that is covered in an undescribed species of *Monophyllaea* (Gesneriaceae), one of two *Monophyllaea* species to be found on limestone in Sabah (Kiew, 1998a). Above soil level surrounding this basin is a wide area where the limestone projects just above the soil surface, forming an uneven and pitted rock pavement, or it outcrops as low cliffs up to 4–5 m high or as boulders of various sizes, all in deep shade below the canopy. It is on soil over limestone that this new begonia species is found.

Specimens examined: SABAH: Pensiangan District – Batu Urun, the type and Ruth Kiew & S. Anthonyamy RK 4472 (K, SAN, SING).

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